DOCUMENT RESUME

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ABSTRACT

A project was undertaken at Kirkwood Community College to develop a full-time and part-time competency based program to educate water and wastewater treatment plant operators. First, a survey was conducted to identify the job tasks performed by the operators, their frequency, importance, and necessity. A questionnaire listing 651 tasks divided into six subject areas (management, human relations, wastewater collection, wastewater treatment, water treatment, and water distribution) was sent out to operators at three job levels. Based on responses from 231 operators, 439 tasks were found to be significant in plant operation. It was then necessary to revise the existing curriculum to address these tasks more fully and to convert it to a competency based format. A competency based testing program was developed to permit students to "test out" of instructional units, and the curriculum was changed to allow entry at various times. To evaluate the program, four types of measurement were used: (1) course effectiveness, measured by a computerized campus system, called SPOT, which is administered to students upon program completion; (2) instructor effectiveness; (3) student skills performance, which includes a basic math skills test upon entry and a remedial program, called PAD, to correct math and reading deficiencies; and (4) postgraduate job performance. (A sample competency based curriculum guide is included for the course, basic laboratory skills.) (ELG)

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ED164858

Identification and Development
of
Competency-Based Curriculum
for
Water and Wastewater Program

Application No. 1-42-74-0104F
Grant No. G007603718
Project No. 498AH60060

Submitted by
Kirkwood Community College
Larry Willis, Program Coordinator
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Ira L. Larson, Superintendent

1978

CE 018 887

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
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Identification and Development of Competency-Based Curriculum
for
Water and Wastewater Program

Objectives and Intended Outcomes

A. Objectives of the proposed project

1. To identify job/task and human relation competencies for successful entry into and advancement within the Water and Wastewater Technology field.
2. To convert the existing curriculum of the Water and Wastewater Technology Program to a competency-based format. A total of four quarters will be converted.
3. To pilot the revised curriculum for a period of one year.
4. To develop a competency based testing program within the Water and Wastewater Technology Program which will be utilized in permitting students to "test out" of any number of instructional units within the program.
5. To identify the necessary math and reading skill levels for entry into the Water and Wastewater Technology Program
6. To develop a testing program to determine the math and reading skill of students requesting admission into the Water and Wastewater Technology Program.
7. To develop and pilot a multi-level variable entry-exit developmental reading and math program with water and wastewater technology subject matter orientations for grade levels six through thirteen.
8. To utilize in the implementaion of objectives 1-7, an advisory committee representing both labor and management from the business and industrial sector, previous graduates of Kirkwood's Water and Wastewater Technology Program, and members of accrediting and licensing boards

9. To provide training to any student regardless of sex, race, religion creed or color.

B. Expected short-range outcomes

1. The cognitive/psychomotor and human relations skills necessary for successful employment in the Water and Wastewater Technology career field will have been identified and competencies written.
2. The Water and Wastewater Technology preparatory program will have been converted to a competency-based instructional format.
3. The math and reading skills necessary for successful completion of the Water and Wastewater Technology Program will have been identified.
4. Mechanisms for assessing the math and reading skills in the program will have been developed and implemented.
5. A multi-level variable entry-exit developmental program with Water and Wastewater Technology subject matter orientations for grade levels 6 - 13 will have been piloted with approximately 25 students participating the first year of implementation.

C. Anticipated long-range outcomes

1. Students will be able to enroll in the Water and Wastewater Technology Program at varying times and levels based on their skills and readiness to enroll.
2. The impact of math and reading skill deficiencies upon successful completion of Kirkwood's Water and Wastewater Technology Program will be minimized.
3. Students will be able to complete the program at differing times based on differing learning rates and levels of achievement.
4. Students will enter the work force throughout the year.

5. Employers and graduates will express satisfaction with the math, science and human relations skills developed in the program
6. Employed Water and Wastewater Treatment Plant Operators will be able to attend short training courses due to the flexibility created by the modularized format of instruction.

D. Evaluation Plan

1. Instructional Program

A third-party evaluator will monitor the progress and evaluate the results of the proposed instructional project. The evaluation plan consists of the following components:

a. The effectiveness of the process and procedures followed throughout the proposal will be evaluated.

b. A comparative study of the existing curriculum versus the competency-based curriculum developed through this grant will be conducted. The study will utilize the Likert and Osgood methodology for measuring attitude and meaning. (The Likert system of measurement as outlined in "Technique for Measurement of Attitudes", Archives of Psychology, 1932, The Measurement of Meaning, University of Illinois, 1957, will not be used. The Charles E. Osgood system of measurement, as described in The Measurement of Meaning, University of Illinois, 1957, will be used.)

c. Student attitude towards the present program curriculum versus the proposed competency-based curriculum will be measured.

d. The effect of competency-based curriculum and developmental programs upon student enrollment, retention and placement and upon employer and student satisfaction in the work place will be measured.

2. **Developmental Program**

The evaluation plan for the developmental program consists of the following components:

a. A pre-post test evaluation.

b. A post student attitude using Osgood system.

c. An evaluation of the program by the instructional staff.

Survey

The following is a final report for the project: Identification and Development of Competency Based Curriculum for Water and Wastewater Program.

The following report is organized into three major sections: (I) Survey; (II) Curriculum; and (III) Measurement. The three sections are divided into three parts: (A) Design; (B) Development; and (C) Evaluation.

An inclusive systematic plan was developed to identify job/tasks and human relation competencies needed for successful entry into and advancement within the Water and Wastewater Technology field. Due to the extensiveness of the amount of materials developed, only significant portions are included.

I. SURVEY

A. Design

Project designers decided that a survey would be the most appropriate means of establishing an accurate overview of the tasks performed by most water/wastewater plant operators across the state of Iowa. A review of the literature indicated that few surveys existed which were applicable to the requirements of this project. A survey was needed which encompassed the general kinds of tasks most probably performed by the largest number of plant operators. The six catagories which were to be included in the survey included (1) plant administration, (2) human relations, (3) wastewater collection, (4) wastewater treatment, (5) water treatment and (6) water distribution. Comprehensive lists of tasks were developed for each of the six job areas. Each of the 651 tasks included were stated behaviorally to accommodate curriculum development. Four catagories of response were developed for each task. The four question catagories were: (1) Frequency of task performance; (2) Understanding of task performance; (3) Difficulty of task performance; and (4) The importance of task performance. The six job sections of the survey were differentiated through the use of six colors of paper.

B. Development

Individually a prototype of the survey was field tested with 20 operators representative of the target population. At least four operators were sampled for each of the four grade certification levels. Also the sample included representative plant levels for each of the four plant grade levels. This gave representative samples of grade level tasks as the tasks are related to plant size and grade level. Revisions were made according to the feedback provided by the operators field tested. Major revisions were made in the administration and human relations catagories of the survey. Further field testing was provided for these two catagories. A major problem encountered with the survey was its overall length. However, few operators held certification in both water and wastewater plant operations. Bids were released to a private firm to print, assemble and mail the survey. Two weeks were allowed for survey returns between the mailing date December 24, 1976 and January 1, 1977. An original copy of the survey can be found in the section entitled "Original Survey Form".

C. Evaluation

Two hundred and thirty nine surveys were returned. However, as total of 831 responses were recorded because a number of the operators held multiple numbers of certificates (i.e. certificates in water treatment as well as water distribution or wastewater treatment, etc.) The official return was tallied under a 10% level of return. However the responses tend to be a good representation of the various operators across Iowa.

The data was analyzed via Kirkwood's computer service. The data was key punched onto computer cards at Kirkwood, and processed through the college's computer center. Two separate computer programs were devised to gain latitude and reliability in the amount of data found. The original t-test was somewhat inappropriate for determining some of the information needed to revise the existing curriculum (i.e. nominal data vs. interval data). Results of the survey may be found in the "Survey Findings" section of this report.

REPORT OF PROGRESS - August 30, 1976 - October 1, 1976

Kirkwood Community College

Curriculum Development - Water/Wastewater Technology

INTRODUCTION

Following is a progress report for the period August 30, 1976 - October 1, 1976, pursuant to the conditions of the project: Identification and Development of Competency-Based Curriculum for Water and Wastewater Program.

The curriculum developer's efforts in connection with the project were initiated on August 30, 1976.

INITIAL ACTIVITIES

Initial activities of the curriculum developer in relation to the project were devoted primarily to becoming familiar with project requirements, with resources available for meeting the conditions outlined in the project proposal, and with the development of a plan for meeting the requirements and conditions specified in the proposal document.

Such activities included the following:

1. Review of the literature
2. Development of a tentative methodology
3. Coordinating activities

REVIEW OF THE LITERATURE

Review of the literature consisted of identification, reading, and/or ordering materials related to the training of persons for employment in the field of water and wastewater technology. Specific effort was directed toward identification and review of previous procedures and achievements in identification of the on-the-job tasks performed by water and wastewater operators and/or the competencies required as a condition of such employment. Certain resources were indicated by materials presently on hand at the training center. Others were revealed through an ERIC search and through a review of materials available at the Kirkwood Learning Resource Center and the University of Iowa libraries. A list of the materials identified is indicated in Appendix A; these are presented as those materials presently on-hand at the water and wastewater training center and those which have been ordered (but not yet received) by the curriculum developer.

Additional efforts included communication with the following:

1. Carl Schwing
   Charles County Community College
   LaPlata, Maryland

Carl Schwing has recently been involved in competency identification and water and wastewater training. Although he was unable to make results available at the time of communication, he indicated that such results would be made immediately available to the Iowa Board of Certification and would be presented at a meeting to be held in Minneapolis in early October. Kirkwood water and wastewater personnel will be represented at the October meeting.

2. Lavoy Haage

Iowa Department of Environmental Quality

Mr. Haage directed the curriculum developer to the study conducted by Southwest Wisconsin Vo-Tech Institute. He was not aware of other resources related to competency identification in the field.

3. American Waste Water Association (AWWA)

Correspondence was directed to AWWA regarding a recent (1976) Canadian Maritime Provinces study in which competencies of operators were identified, and modules based on this competency identification were developed.

Other literature reviewed included the following:

1. The grant proposal.
2. The Iowa Statewide Plan for Water and Wastewater Treatment Operators.
3. The Iowa Proposed Water and Wastewater Treatment Certification and Training Program.
4. Various training modules previously developed, including those by: Clemson University, U. S. Environmental Protection Agency, Kirkwood Community College, Alabama State Department of Education, and others.
5. Various books and articles concerning the general topics of competency-based curriculum and instruction.

DEVELOPMENT OF TENTATIVE METHODOLOGY

A tentative general plan for competency identification was developed; this plan, as revised by the KCC water and wastewater staff is indicated in Appendix B (tentative deadline dates established are also indicated.)

COORDINATING ACTIVITIES

The curriculum developer has initiated activities to coordinate the efforts of others involved in the area of competency-based education and module development at Kirkwood Community College. Such activities are indicated below.

Organization	Persons	Activities
F.I.P.S.E. (Fund for the Improvement of Post-Secondary Education)	Dave Bunting Margaret Poorman	1. Overview of past F.I.P.S.E. efforts. 2. Coordination of in-service plan for all persons involved with C.B.E. at KCC. 3. Development of format to be utilized in the conversion of present curriculum to a competency-based format, including a question guide for instructors and an example (See Appendix C.)
DEQ	Charlie Bardonner Lavoy Haage Charlie Miller Larry Willis	Certification meeting in Ames.
O.S.H.A. Training	Joe Klinsky	Development of C.B.E. format
P.A.P. Personal Achievement Program	Jean Goodnow Jan Swinton	Coordination of present and anticipated activities related to the water and wastewater grant.

Organization	Persons	Activities
Water and Wastewater Personnel	Charles Bardonner Doug Feil Phil Koundakjian Joe Robertson John Weber	1. Orientation meeting: Concepts of C.B.E. and present training program conversion were discussed. 2. In-Service meeting a. General plan for competency identification was discussed. Deadline dates were proposed. (See Appendix B.) b. Instructors were given copies of: task inventory resources (Appendix A) and proposed competency based format (Appendix C.) c. A discussion of the components of a C.B.E. module was discussed. Methods and procedures for conversion were also covered. Instructors will begin initial efforts immediately. (See Appendix B, Page 2).

PLAN FOR TASK INVENTORY DRAFT

Instructors have taken the responsibility for reviewing task inventories on hand and for contacting personnel working in the water and wastewater fields for the purpose of drafting a list of the job tasks performed by persons in the water and wastewater field. Responsibilities were assigned as indicated in the following 4 x 4 matrix.

	Wastewater Treatment	Water Treatment	Wastewater Collection	Water Distribution
Operations	John Weber	Phil K.	John Weber	Phil K.
Maintenance	John Weber	Phil K.	John Weber	Phil K.
Laboratory	Doug Feil	Doug Feil	Doug Feil	Doug Feil
Management	Joe Robertson	Joe Robertson	Joe Robertson	Joe Robertson

The task inventory instrument will be divided into the four general occupational categories indicated at the top of the matrix, these categories are congruent to the four areas of certification for water and wastewater treatment operators proposed by Iowa DEQ. The categories listed vertically, on the left hand side of the matrix are for internal management of the task inventory only, but are in general accordance with the general criterion behavior categories outlined in CEWT curriculum guidelines.

After completion of the draft of the task inventory instrument, it will be reviewed internally, and then by the water and wastewater Advisory Committee as well as other competent authorities to be identified by Charlie Bardonner.

Coordination with P.A.P. personnel for input to the task inventory draft is the responsibility of the curriculum developer.

SIGNIFICANT PROBLEMS AND PROGRESS TOWARD SOLUTIONS

The following have appeared as past, present, and anticipated problems. Progress, if any, toward the solution to these problems is also indicated.

WORKING CONDITIONS

The physical facilities in which all personnel were to work were not conducive to productive effort through much of September. Recently office space, in the form of a trailer has alleviated a good deal of this problem.

INSTRUCTOR TIME

Instructors are so heavily engaged in the tasks of preparation for classroom teaching and the conduct of classroom instruction and workshops that it has been nearly impossible for effective coordination of their efforts with those of the curriculum developer to take place. Recently, the improved working conditions have made effective future coordination more probable. The problems of new instructors and new curriculum compound the time problem.

It is anticipated that time will continue to be a problem. Efforts to schedule specific times for coordination and internal in-service training are anticipated.

MATERIALS ORDERED

Unless task inventory materials on order arrive within two or three weeks, they will be of little use to instructors, provided tentative deadlines are met.

Unusually slow turn-around times have been observed in the filling of such requests.

INSTRUCTIONAL METHODOLOGY

It has often been said that instructors tend to use an approach to teaching which is similar to the approaches or methodologies used by their instructors in the past.

Although instructors in the water and wastewater training center have expressed a willingness to cooperate in the conversion of the existing curriculum to a competency-based format, it is anticipated that certain attitudinal changes may be difficult to accomplish, particularly in the area of instructional methodology.

SUMMARY: SIGNIFICANT ACCOMPLISHMENTS

1. Available literature concerning task and competency identification has been reviewed and/or ordered. A list of such literature has been made available to instructors.
2. A general plan for competency identification has been developed. This plan has been revised and accepted by water and wastewater personnel. Tentative deadlines have been established.
3. Water and wastewater personnel have received some preliminary inservice training on conversion to a competency-based instructional format.
4. Effort to coordinate activities with F.I.P.S.E. and P.A.P. personnel has been made.

APPENDIX A

TASK INVENTORY

Sources on Hand

1. Austin, John H. and Kesler, John, editors. Educational Systems for Operators of Water Pollution Control Facilities, Clemson University, Clemson, S. C.: 1969. (Microfische) ED 059582.

2. AWWA, Suggested Course Outline for Water Distribution System Operators. Vol. I - III, 1967.

3. AWWA, Suggested Training Outlines for Water Treatment Operators. Vol. I - III, 1970.

4. Clark, Anthony B., and others. An Analysis of the Wastewater Treatment Maintenance Mechanic Occupation. Ohio State University, Columbus, Ohio: 1975. (Microfische) ED 107998.

5. Environmental Protection Agency. Volume II: Curriculum Guidelines--Criteria for the Establishment and Maintenance of Two Year Post High School Wastewater Technology Training Programs. Prepared by Clemson University, Clemson, South Caroline: 1971.

6. Environmental Protection Agency. Guidelines to Career Development for Wastewater Treatment Plant Personnel. Prepared for the Public Service Careers Section, Office of Education and Manpower Planning, Environmental Protection Agency. Washington, D. C. September, 1973.

7. State of Washington. Training Requirements and Specifications for Wastewater Treatment Plant Operators. State of Washington Coordinating Council for Occupational Education, Trade, Industrial and Technical Education Section. Olympia, Washington: 1971.

8. Stegeman, Gary L., Wagner, Daniel J. and Anderson, Ronald H. Final Report: Assessment and Determination of Basic Competencies Necessary for Utility Operators Utilizing Ground Water Supplies, Part I. Southwest Wisconsin Vocational-Technical Institute. Fennimore, Wisconsin: March, 1975.

9. U. S. Army Occupational Survey Branch, Military Occupational Data Bank Questionnaire: MOS 51-N--Water Supply Specialist. Department of the Army, Alexandria, Virginia: Undated. *

10. Clark, John B. and others. An Analysis of the Wastewater Treatment Operator Occupation. Ohio State University, Columbus, Ohio: December, 1974. (Microfische) ED 110736. *

11. Hillison, John H. and Warmbrod, J. Robert. Manpower Needs in Environmental Management: Research Report of a Graduate Study. July, 1972. (Microfische) ED 068632. *

* (Ordered--Received 9-28-76)

12. Environmental Protection Agency. Manpower Requirements for Wastewater Collection Systems in Cities and Towns up to 150,000 Population. June, 1973.

TASK INVENTORIES, ORDERED

1. Environmental Protection Agency. Estimating Staffing for Municipal Wastewater Treatment Facilities. March, 1973.
2. Environmental Protection Agency. Estimating Costs and Manpower Requirements for Conventional Wastewater Treatment Facilities. October, 1971.
3. Task Inventory Exchange. Wastewater Treatment Laboratory Technician, Vocational and Technical Research Project.
4. Task Inventory Exchange. Wastewater Treatment Operator. Vocational and Technical Agriculture Research Project.
5. Task Inventory Exchange. An analysis of the Wastewater Treatment Operator Occupation.
6. Environmental Protection Agency. Guidelines to Career Development for Wastewater Plant Personnel, 1973.
7. Environmental Protection Agency. Estimating Costs and Manpower Requirements for Conventional Wastewater Treatment Facilities. 1971.
8. Environmental Protection Agency. Manpower Requirements for Wastewater Collection Systems in Cities and Towns up to 150,000 in Population. 1973.
9. Environmental Protection Agency. Estimating Staffing for Municipal Wastewater Treatment Facilities. 1973.
10. The Economics of Clean Water. Vol. III, U. S. Dept. of the Interior.

APPENDIX B

Project Tasks

This list of project tasks are (to date) still valid and accurate and still reflects the necessary steps that need to be taken for project completion. Some modification of time deadlines for various task completion must be made; however, as previous earlier estimated completion dates were in error. Previous development has taken longer than earlier expected. The following is a list of the tasks that have already been completed. This list is in essence a summary of project status - what I as curriculum developer (with appropriate assistance) have accomplished and also what has been done in fulfilling the grant proposal of this project as of June 14, 1977. Since this report occurs half way through the year it may also be looked upon as a mid-point review.

12/76	Survey Development - completed General Plan for Competency Identification
10/14/76	Review existing task/competency job analyses - completed
10/14/76	Devise competency interview/survey instrument according to an acceptable structure. Coordinate with Personal Achievement Program (PAP) personnel-completed.
10/27/76	Have instrument reviewed by Advisory Committee and other competent authority and solicit suggestions completed.
11/76	Revise competency identification instrument (coordinate with PAP personnel) - completed
11/76	Field test interview/survey instrument and no. of operators - completed.
12/76	Revise instrument - coordinate with PAP personnel - completed.
1/12/76	Implement interview survey - completed.
1/26/76	Complete interview survey - completed.

4/30/77	Attitudes test of pre-existing program - completed.
7/30/77	Conversion of pre-existing program to C.B.E. format including objectives, interim levels, conditions, etc., partially completed.
3/30/77	Identify the necessary math skills for entry into the Water and Wastewater Technology Program - mostly completed.
3/30/77	Develop and pilot a multi-level variable entry exit developmental math program with Water and Wastewater technology subject matter orientations for grade levels six through thirteen - mostly completed.

The following is a list of tasks still needed to be completed with new estimated date modification.

8/1/77	Compile and analyze data. Coordinate with PAP personnel. See Appendix A.
8/30/77	Translate results of data analysis into program needs. Coordinate with PAP personnel.
8/30/77	Skill and knowledge additions to pre-existing curriculum.
8/30/77	Skill and knowledge deletions to pre-existing curriculum.
8/30/77	Reemphasis of material in new curriculum.
9/1/77	Approval of Advisory Committee and other qualified personnel.
10/1/77	Conversion of pre-existing program to C. B. E. format including objectives, criterion levels, conditions etc.
10/14/77	Approval of Advisory Committee and other qualified personnel.
10/31/77	Validation of random units and modules, individually, and small group tryouts, pre-tests, post tests, and attitude tests.
11/1/77	Approval of Advisory Committee and other qualified personnel.

11/15/77 Conversion of C. B. E. programs to variable entry exit, operation tryout (modules and sequences established,) complete instructional sequences tested, pretests, post tests and attitudes.

11/18/77 Approval of Advisory Committee and other qualified personnel.

11/1/77 Pilot revised curriculum for one year.

Identify the necessary reading skills for entry into the Water and Wastewater Technology Program. (To be done by Jan Swinton)

Develop and pilot a multi-level variable entry exit developmental reading program with Water and Wastewater technology subject matter orientations for grade levels six through thirteen. (To be done by Jan Swinton)

APPENDIX C

(Question)

Module:	
Module Section Name:	

Rationale:

Why should the student be able to perform the indicated task(s) or why should he/she acquire the knowledge, skill(s) or attitudes indicated by the objective(s) below?

Prerequisites:

1. What previously acquired knowledges, skills and/or attitudes must the student have in order to successfully complete this module section?
2. How does the instructor determine that the student has the required prerequisites?

Competencies (Job Oriented): The purpose of the module section is to allow the student to develop the ability to perform certain tasks which have been identified as critical to performance on the job. When the student has developed this ability, he/she is said to have the necessary competency to perform the indicated tasks.
After mastery of the objectives of this module section, what competency or competencies will the student possess?

Performance Objectives (Instruction-Oriented):

1. What will the student be given which will allow him/her to perform the activity or task specified? [illegible]
2. What should the student be able to do after completing the learning activity?
3. How will the instructor and student know when the student has performed successfully? standards

Assessment:

1. Test out features -- How does the instructor determine students who already possess the knowledges, skills and/or attitudes which this module section intends to develop?
2. How does the student know when he/she possesses these knowledges, skills, and/or attitudes?

(Question)

MODULE SECTION NAME:

LEARNING COMPONENT

Principal Learning Activities:

What does the student do which enables him/her to accomplish the objective?

Alternate Learning Activities:

In what other ways can the student acquire the knowledges, skills, and/or attitudes necessary to accomplish the objective?

Materials and Media:

List here:

1. What materials will be needed for the learning activity?
2. What media is required?

Terminology:

What words will the student need to be able to define or identify in order to accomplish the objective?

Additional Comments/Notes:

(Example)

UNIT NAME: I Plumbing

PURPOSE OF UNIT: To develop the learner's competencies in the specific skills used in the installation, maintenance, and repair of water supply, drainage, and gas supply systems made up of piping, piping fixtures, appliances, and fittings.

MODULE NAMES:

1.1 Selecting Materials and Fabricating Joints
1.2 Assembling and Testing Piping Materials
1.3 Planning a Residential Cold Water Distribution System
1.4 Planning a Hot Water Supply Distribution & Gravity Flow Circulating System
1.5 Kitchen Drainage Systems
1.6 Complete Residential Soil and Waste Drainage Systems
1.7 Roughing-In Gas Piping
1.8 Installing Gas Vents
1.9 Drainage and Waste Vent
1.10 Installing a Residential Drainage and Waste Vent System
1.11 Planning Fixture Drainage Rough-In
1.12 Installing Plumbing Fixtures
1.13 Repairing Leaking Pipes
1.14 Reparing and Adjusting Malfunctioning Fixtures

(Example)

MODULE SECTION NAME: The Plumbing Code

LEARNING COMPONENT

Principal Learning Activities: Participate in instructor's presentation(s) that will include the following subject content: plumbing industry, basic safety rules, and local plumbing code. View the film on shop safety and know the safety rules dealth with in the film. Read in text, p. 24-37 and write and know definitions for words found in terminology section - local plumbing code will be useful for this.

Alternate Learning Activities: View instructor's presentations on videotape and listen to supplemental audio tapes. Other same as above.

Materials and Media:

Film - Shop Safety" - 16 mm - 24 min.
Videotapes - "Plumbing Industry, an Overview," "Intro to Local Plumbing Code"
Audio Tapes - Plumbing Introduction(s)
Transparencies - Plumbing - 3M Company

Terminology:

Air Gap
Backflow
Back Syphonage
Cesspool
Circuit Vent
Diameter
Flat Vent
Flush Valve
Local Vent
Relief Vent
Riser
Sewage
Utility Vent
Waste Pipe
Yoke Vent

Additional Comments/Notes:

Field Trip to local plumbing establishment and on site work can be arranged.

IPBN - Consumer Report - The Plumbing Industry - Thursday, 9 p.m. - have videotaped.

(Example)

UNIT NAME: I Plumbing

MODULE NAME: 1.1 Selecting Materials and Fabricating Joints

MODULE SECTION NAMES:

1.1.1 The Plumbing Code
1.1.2 Soldering Copper Pipe
1.1.3 Threading Steel Pipe
1.1.4 Fabricating Plastic Pipe
1.1.5 Fabricating Cast Iron Pipe
1.1.6 Selecting Materials and Fabricating Joints

(Example)

Module: 1.1 Selecting Materials and Fabricating Joints

Module Section Name: 1.1.7 The Plumbing Code

Rationale: A thorough understanding of the local plumbing code is essential to the plumber when determining the type of pipe to be selected for specific situations by identifying types of piping materials to be used for any plumbing installations.

Prerequisites: None

Competencies (Job Oriented):

Understand and use the plumbing code.
Know basic safety rules for plumbers.

Performance Objectives (Instruction-Oriented):

The learner will with the use of the local plumbing code, correctly describe the location and use of piping materials in given situations. In class simulation, the learner will adequately demonstrate the basic safety rules for plumbers in 9 out of 10 situations.

Assessment: Given any ten situations which describe the location and use of the piping materials, the learner will identify the type of piping material to be used forthe situation. The local plumbing code will be used as a reference, and the learner must correctly identify eight of the types of piping materials in given situations.

UNIT NAME:
MODULE NAME:
MODULE SECTION NAMES:

UNIT NAME:
PURPOSE OF UNIT:
MODULE NAMES:

MODULE SECTION NAME:
LEARNING COMPONENT **Principal Learning Activities:**
Alternate Learning Activities:
Materials and Media:
Terminology:
Additional Comments/Notes:

Module:

Module Section Name:

Rationale:

Prerequisites:

Competencies (Job Oriented):

Performance Objectives (Instruction-Oriented):

Assessment:

MEMO TO: Charles B. Bardonner

FROM: John R. Kelley

DATE: October 4, 1976

As the result of our meeting with the instructors of the water and wastewater training center on Thursday, September 30, 1976, I am convinced of the need for each instructor to interview a minimum of six persons who are now performing in the jobs related to the areas which were identified in the 4 x 4 matrix used to assign responsibilities for the task analysis. The six interview minimum is in keeping with the Lucy Crawford model for identification of competencies which the grant proposes to utilize.

I feel that such interviews will:

1. Serve to fill in the gaps in knowledge of the instructors concerning what water and wastewater operators do on the job and,
2. Will make the first draft copy of the competency identification instrument more valid and more acceptable to initial reviewing authorities.

I suggest that the questions to be addressed in these interviews include, but not be limited to, the following:

1. What is the most essential task you perform on the job?
2. How frequently do you perform this task?
3. What is the next most essential task you perform? How often?
4. Describe, if possible, other tasks performed on the job in descending order of importance. Indicate how frequently you perform each task.
5. Describe other tasks performed on the job and indicate the frequency of performance.

I think each interview should begin with a description of the purpose for this task analysis.

Information gathered on each person interviewed should include, in addition to the task information, at least the following:

1. Name of operator.
2. Certification level of operator.
3. Experience of operator, i.e. length of time on the job totally and at the present certification level.

4. The cell or cells of the 4 x 4 matrix addressed, e.g. John Weber would record Operations--Wastewater Collection when interviewing a person with responsibilities in this area.

5. Name of plant.

6. Classification of plant.

7. Date of interview.

8. Other information deemed appropriate by you and/or the interviewers.

All of the aforementioned information should be recorded mechanically, or as a less desirable alternative, in writing, in order that it is easily accessible to the person developing the initial draft copy of the task inventory. Such information should also be maintained for future reference.

I am presenting these suggestions to you in this manner because I will be attending (as you requested) the National Conference on Research Management in Vocational Education (in St. Louis) for the remainder of this week. Due to our intended deadlines, I felt it necessary to get these suggestions to you as soon as possible.

mrm

MEMO TO: Charles B. Bardonner

FROM: John R. Kelley

SUBJECT: Third Party Evaluation tasks for the Project Titled Identification and Development of Competency-Based Curriculum for Water and Wastewater Program

DATE: October 14, 1976

EVALUATION--OBJECTIVES AND ACTIVITIES

The project proposal, under the major heading of "Objectives and Intended Outcomes" implies under the heading "Evaluation Plan", subheading "Instructional Program" that the following activities are to be conducted by a third-party evaluator:

A third-party evaluator will monitor the progress and evaluate the results of the proposed instructional project. The evaluation plan consists of the following components:

a. The effectiveness of the process and procedures followed throughout the proposal will be evaluated.

b. A comparative study of the existing curriculum versus the competency-based curriculum developed through this grant will be conducted. The study will utilize the Likert and Osgood methodology for measuring attitude and meaning. (The Likert system of measurement as outlined in Technique for Measurement of Attitudes", Archives of Psychology, 1932, The Measurement of Meaning, University of Illinois, 1957, will be used. The Charles E. Osgood system of measurement, as described in The Measurement of Meaning, University of Illinois, 1957, will be used.)

c. Student attitude towards the present program curriculum versus the proposed competency-based curriculum will be measured.

d. The effect of competency-based curriculum and developmental programs upon student enrollment, retention and placement and upon employer and student satisfaction in the work place will be measured.

Under the major heading "Description of Proposed Project", heading "Evaluation Activities", subheadings "Instructional Program--First 12 Months" and "Final Six-Month Period", the following activities are listed:

1. Develop an instrument for the advisory committee to utilize in evaluating the present curriculum. The instrument will attempt to measure attitudes about specific characteristics of the program. The Likert System of measurement will be used.

2. Develop an instrument to evaluate student attitudes towards the present curriculum. The instrument designed will attempt to measure attitudes towards specific characteristics of the program, (Likert) as well as an overall attitude toward the program (Osgood).

3. Develop an instrument to measure employer and current program graduates' satisfaction with skills acquired to succeed in the work place. (Likert system)

4. Implement the evaluation of the present curriculum by advisory committee members, students and employers.

Final Six-Month Period

1. Implement the evaluation of the new competency-based curriculum by the advisory committee members utilizing the same instrument used the first year. A comparison of both evaluation results will be conducted by computation of an analysis of variance utilizing the F-statistic as described by Lindquist in *Design and Analysis of Experiments in Psychology and Education*, 1953. Assuming a significant "F", t-statistics will be computed as described by Blommers and Lindquist, *Elementary Statistical Methods in Psychology and Education*, 1960.

2. Implement student attitudinal instrument for the new competency-based curriculum. The statistical procedures outlined in step 1 will be followed.

3. Implement evaluation of employer and program graduates' satisfaction within the work place with skills acquired from competency-based instruction. The statistical procedures outlined in step 1 will be followed.

4. Draw comparisons between the advisory committee evaluations of traditional curriculum and competency-based curriculum, employer and program graduates' satisfaction in the work place with acquired skills, from traditional and competency-based curriculum, and student attitude toward the traditional curriculum and the competency-based curriculum.

Match-up--Objectives and Evaluation Activities

*A - First 12 Months
B - Final 6 Month Period

Page 11 - (Third Party	Pages 16 - 17
a. Evaluate effectiveness of process and procedures throughout the proposal.	
b. Compare existing curriculum vs. competency-based curriculum (attitude and meaning)	1A. Develop an instrument for the advisory committee to use in evaluating the present curriculum. 4A. Implement eval. of present curriculum by advisory committee.

	1B. Implement evaluation of new curriculum by advisory committee using instrument from 1A; compare results of 4A and 1B.
c. Measure student attitude toward present curriculum vs. proposed competency-based curriculum.	2A. Develop an instrument to evaluate student attitudes toward the present curriculum. 4A. Implement evaluation of present curriculum by students.
	2B. Implement student attitude measure for new curriculum. Use instrument from 2A; compare 4A and 2B.
d. Measure effect of competency-based curriculum and developmental programs upon student enrollment retention, and placement and upon employer and student satisfaction in the work place.	3A. Develop an instrument to measure employer and current program graduates' satisfaction with skills acquired. 4A. Implement evaluation of present curriculum by employers.
	3B. Implement evaluation of new curriculum by employer and program graduates. Compare 4A and 3B.
	4B. Compare: Advisory committee evaluations of present and new curriculum, employer and program graduates' satisfaction in work place with skills acquired from traditional and new curriculum, student attitude toward traditional and new curriculum.

Problems--Objectives and Evaluation Activities

Note that objective a, Page 11, does not appear to match-up with the evaluation activities proposed on Pages 16 - 17. The questions that need to be addressed relative to this objective (a) are the following:

1. Who will the third party evaluator be?

2. How will the third party evaluate the effectiveness of the process and procedures?

3. When should the third party begin this evaluation, in light of the objective that it will be conducted "throughout the proposal"?

4. Where will the funds to pay the third party evaluator come from (none are budgeted)?

For objective b, it appears that the advisory committee is to serve as the third party evaluator, and also as the persons whose attitudes are to be measured. I assume that the intent was that the evaluation instrument is to be developed by the project staff. Clarification on the accuracy of this assumption may be helpful. The role of the third party, evaluator or evaluatee, should also be defined; it seems somehow incongrous that the advisory committee would be a third party evaluator of its own attitudes. Objective c and its "match-up" elements indicates that student attitudes are to be measured. Again, it appears that the third party in this case is the students who would be evaluated. Objective d appears to be similarly addressed. Perhaps it was the intent of the project writers that the project staff develop the instrument, administer it to a "third party", analyze the data and then interpret the results, although this rationale does not in the strictest sense appear to be in keeping with the intent that a third party be utilized to conduct the evaluation in order to ensure objectivity. It would be helpful to clarify the role of the third party evaluator for objectives b, c, and d, in light of the aforementioned problems.

Objective d poses an additional problem. The project staff is to develop curriculum for a one year program during the first twelve months of the project. This curriculum is to then be implemented during the next one year of the program, the first six months of which coincide with the final six monthsof the project. Objective d and its corresponding evaluation activity (3B) indicates that, in addition to its effect on enrollment and retention, the effect of the new curriculum on the placement of students as well as employer's and program graduates' satisfaction within the work place with skills acquired from the competency-based instruction will be measured. Yet, it is assumed, the bulk of the students engaged in competency-based instruction will not even be placed until at least six months after the completion of the grant project! It will be likewise impossible to measure employer's and student's satisfaction, etc., during the period of the grant. This point needs to be addressed. Perhaps it points the way to the writing of another grant which, in effect, extends the present project for 9 - 12 months in order that the follow-up evaluation related to objective d and activity 3B might be accomplished.

Summary

In brief, I feel that the role of the third party evaluator (who, what, when and how funded), as it related to project objectives and proposed evaluation activities, needs to be specifically defined in order to properly proceed with the project.

REPORT OF PROGRESS - November 15, 1976 - December 13, 1976

Kirkwood Community College

CURRICULUM DEVELOPMENT - WATER/WASTEWATER

INTRODUCTION

The following is a Progress Report for the period November 15, 1976 - December 13, 1976, according to the conditions of this project: Identification and Development of Competency-Based Curriculum for Water and Wastewater Programs.

5

REVIEW OF THE LITERATURE

Most of the review of the literature consisted of reading materials left by Dr. Kelly. These materials included:

1. Southwest Wisconsin Voc-Tech Institute.
2. Review of Eric search.
3. Review of material from the University of Iowa libraries.
4. Material from the Kirkwood Learnigg Center.
5. Grant proposal and budget input form.
6. Technical publications.
7. Dr. Kelly's Progress Report, attached appendices, and various memorandums.
8. Review of treatment certification program.
9. Various training modules previously developed.
10. Various books and articles on competency-based curriculum and water/ wastewater technology.
11. The Iowa proposed water and wastewater treatment certification and training program.
12. Review of first draft of survey as developed and left by Dr. Kelly.
13. Communication with Lavoy Haage concerning the water/wastewater certification program and survey.
14. Communication with various instructors concerning input into the survey.

Materials Ordered

Colored and white paper for printing of the survey received from central stores. See requisition for breakdown.

Requested information on maintenance courses and workshops from:

George A. Kinias
Director, Environmental Training Center
Indiana Vocational Technical College

Requested a list of all current water/wastewater programs in U. S. from:

Mrs. Pat Powers
Office of Water Programs
Environmental Protection Agency
Washington, D. C.

Materials Received

Colored and white paper received feom central stores 12-13-76.

Curriculum materials, Department of the Air Force 10-10-76

Contacts

1. Julie Lichtenburger - Iowa Department of Environmental Quality
2. Denny Alt - Iowa Department of Environmental Quality
3. Mike Kelly - Community Relations
4. Daryl Lockhart - Department head - Welding
5. Margaret Poorman - Curriculum Developer
6. Dave Bunting - Curriculum Developer - FIPSE
7. Lavoy Haage - Iowa Department of Environmental Quality
8. Jerry Leibold - Editor, Joint newsletter - Iowa Section of American Waterworks Association and Iowa Water Pollution Control Association.
9. Jan Swinton - Reading Specialist
10. Debbie Rozeboom - Reading instructor
11. Kathy Davis - Math instructor
12. Pam Peart - Math specialist
13. Jean Goodnow - Counselor/Coordinator
14. Jim Wing - Central Receiving
15. Fred Shilhanek - Printing
16. Dick Holt - Data Processing and computing
17. John Weber - Water/Wastewater instructor

18. Doug Feil - Water/Wastewater instructor
19. Joe Robertson - Water/Wastewater instructor
20. Phil Koundakjian - Water/Wastewater instructor
21. Charles Bardonner - Department Head - Environmental Occupations
22. Harold Kort - Associate Department Head - Environmental Occupations
23. Larry Willis - Director of Career Education
24. Direct Mailing Company
25. PIP Mailing Company
26. Land Mailing Company

Interviews

Leo Cron, Superintendent, Iowa City Water Pollution Control - concern survey development

Harry Boren, Superintendent from Water/Wastewater - survey development.

Norm Maranda, Assistant superintendent - survey development.

George Milligan, Superintendent, Cedar Rapids Water/Wastewater Plant - survey development.

Survey Development

During the past four weeks the following progress on survey development has been made.

Revisement of the instrument after being randomly field tested by some 20 operators, supervisors, and advisors. In this final revisement each of the four major categories were somewhat revised, while the sections on management and human relations received major revisions. Besides feedback from the field test, additional expertise and critique was obtained from the Advisory Committee in the form of interviews. This plus pertinent literature and the curriculum developer's arm expertise served as the major source for revisement. Valuable input was also received from curriculum developer Margaret Poorman and Davee Bunting. Mike Kelly assisted input on cover page.

Present Survey Stage

Currently the survey has been typed and awaits only final polishing. The Direct Mailing Company (who has been awarded the job) has received the necessary paper for printing. Estimated mailing date is projected to be Dec. 24, 1976. The two necessary requisitions have been prepared. Requisition approval is still pending. A letter was sent to Jerry Leibold, editor of the joint newsletter, Iowa Section of American Waterworks Association and Iowa Water Pollution Control Association in regards to announcing the survey. It is hoped that the additional publicity in advance of the actual survey will result in greater survey returns.

Survey returns are projected to begin coming in during the first week of January.

Alternatives to Poor Returns

This curriculum developer and Charles Bardonner discussed the possibility of poor returns which in this curriculum developer's estimate would consist of less than 10% or 300. If such were the case the following options were discussed.

1. The use of a follow up letter to those non-returnees.
2. The use of a letter to the manager or superintendent of each plant asking them to talk to their men personally about completing and returning the survey.
3. The possibility of giving CEU credit was discussed but did not receive approval.

Data Analysis and Computer Programming

Arrangements have been made with Dick Alt over the statistical analysis to be employed. Each alternative for every question will receive a percentage breakdown. The results will then be further analyzed and broken down over 58 categories. No confirmed time length or finishing date for the completion of the computer analysis has been given. Factors affecting completion time are length of survey, number of surveys returned, available working hours of computer and key punch work staff, and number of other projects ahead of this one and their length.

Preparation for Curriculum Revision

Initial efforts have been made to schedule appointments with the staff to discuss the present existing water/wastewater curriculum and present teaching methodologies. Such arrangements will apparently be made on a one to one basis on each instructor for a different schedule. This does not appear to present any problems at the present time. Unfortunately the existing curriculum (modular) has only been in effect for one quarter, and has not been established. This part of the pre modular program may have to be used for reference purposes in establishing the new curriculum.

Fulfillment of Project Objectives

5. Identification of necessary math and reading skills for entry into the Water and Wastewater Technology Program.

6. Development of a testing program to determine the math and reading skill of students requesting admission into the Water and Wastewater Technology Program.

7. To develop and pilot a multi-level variable entry-exit developmental reading and math program with Water and Wastewater Technology subject matter orientations for grade levels six through thirteen.

Initial steps have been taken by the curriculum developer and Jan Swinton to secure the above objectives. Although in reality a math test is presently available with Water/Wastewater subject matter orientations future workshops and follow up meetings are to be scheduled for January and February where the staff reading and math specialists along with the curriculum developer will work together on this matter. Jan Swinton and others have presently developed tests identifying math reading skills to be later incorporated into the Water Wastewater subject matter setting. In addition the curriculum developer has contacted Pat Powers of the EPA.

For the purpose of obtaining a list of all current Water/Wastewater schools in the U. S. This can provide valuable information on reading math skills identification competency levels in existing programs.

Establishing a General Outline

At the request of Charles Bardonner and out of necessity, initial efforts have been conducted towards the formalizing of a general outline for the project. This outline will contain developmental, implementation, evaluation concerns of the project. The purpose of this outline is to incorporate the general project schema (what needs to be done) with a tentative approach (what will be done). This is important because it establishes a future direction of activities.

Summary of Significant Accomplishments

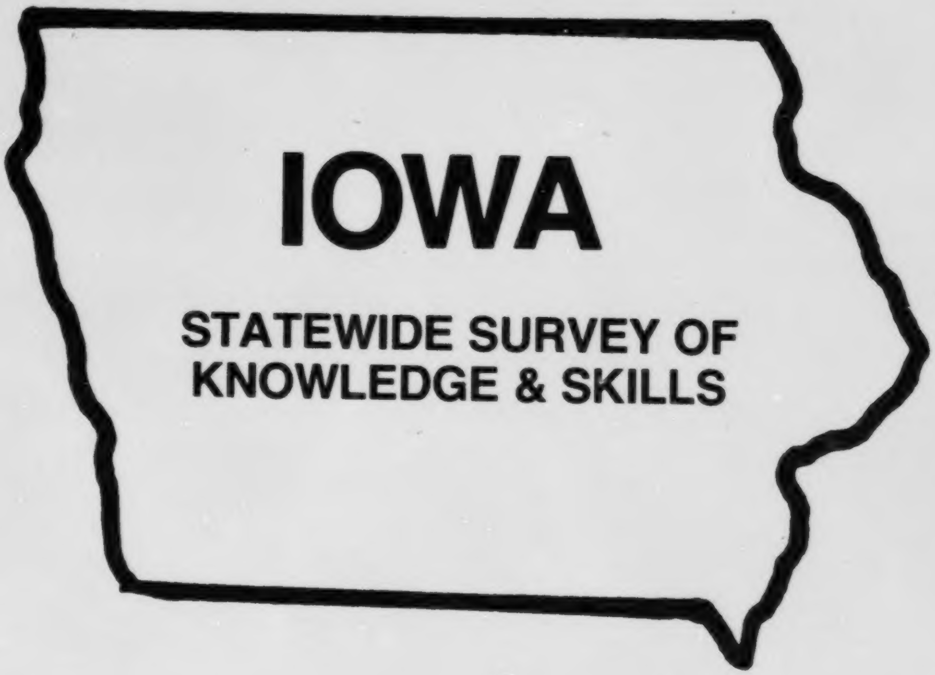
1. Completion of survey instrument

2. Initiating the coordination of math and reading skill development.

3. Preparation and arrangement of data analysis of survey.

4. Beginning preparations for curriculum revisions.

Original Survey Form



IOWA

STATEWIDE SURVEY OF KNOWLEDGE & SKILLS

NEEDED BY
WATER AND WASTEWATER
OPERATORS
1976

CONDUCTED BY
THE WASTEWATER PLANT OPERATOR TRAINING CENTER
KIRKWOOD COMMUNITY COLLEGE

Dear Operator:

The Water and Wastewater Training Center at Kirkwood Community College is trying to provide students at Kirkwood, as well as operators like yourself, working in the field, with a kind of training that is related to the knowledge and skills needed by operators on the job.

In order to determine the knowledge and skills needed by operators on the job, we have developed a statewide survey of water and wastewater operators. This survey is enclosed. The very fact that you are working in the water and/or wastewater field in Iowa, enables you to make a significant contribution to this survey. Your responses to the enclosed survey will help provide information about what operators are actually doing on the job. Please respond to each survey item in terms of what you must know or do in order to best perform your job.

Your responses will be held confidential. Please complete the appropriate portions of the survey and return it to us in the enclosed envelope, (return postage is already paid.)

We realize that you are busy, but we hope you can find the time to give us the benefit of your experiences. We hope that the result of your effort and ours will be a more practical and effective training program for future, as well as present operators. Any questions concerning the survey or training project may be addressed to the curriculum developer or other project staff member by phoning, toll free 1-800-332-8156. Thank you for your cooperation.

Charles B. Bardonner Department Head Environmental Occupations Kirkwood Community College	Gary Feldman Curriculum Developer Water and Wastewater Training Project Kirkwood Community College

Date ____________________

OPERATOR INFORMATION

Please complete the following information about the plant or plants where you are employed and about yourself:

1. Name of plant(s) ____________________

2. Classification of plant(s) a. I ______ c. III ______ e. Other ______
   b. II ______ d. IV ______

3. Your certification type or types and level or levels.
   Example: Wastewater, Grade II
   Water Treatment, Grade I
   a. ______ Grade I
   b. ______ Grade II
   c. ______ Grade III
   d. ______ Grade IV
   e. ______

4. Time, in years and months, you have held each certification level indicated above in Item 3.
   a. ______
   b. ______
   c. ______

5. Please indicate the area or areas in the list below in which you are principally employed.
   a. ____ Wastewater, both collection and treatment
   b. ____ Wastewater collection
   c. ____ Wastewater treatment
   d. ____ Water, both treatment and distribution
   e. ____ Water treatment
   f. ____ Water distribution
   g. ____ Other (Please write name of area here ____________________)

6. Time, in years and months, you have worked in the area or areas you indicated in Item 5 above. Please write name of area(s) and number of years and months worked in each.

   a. ____________________

   b. ____________________

   c. ____________________

7. Please indicate if you are working part time or full time.

   a. _____ Part time

   b. _____ Full time

THANK YOU FOR PROVIDING THIS INFORMATION

Please see the instructions below to continue.

GOOD NEWS!!!

It will not be necessary for all operators to fill out every item in this survey. However, it is felt that certain management and human relations knowledges and skills are common to all four occupational categories: Wastewater Collection, Wastewater Treatment, Water Treatment and Water Distribution. For this reason, we are asking every operator to complete the following management and human relations sections.

Below, and on the following white pages, are listed a number of management and human relations knowledges and skills to be performed by many operators.

For each item listed, please check the box which shows how often you are required to use the knowledge or skill indicated.

HOW OFTEN

NEVER - Check this box in the How Often column if you do not use this skill or knowledge in your job.

ONCE OR MORE A DAY - Check this box in the How Often column if you use this knowledge or skill at least once a day on your job (365 times per year).

ONCE OR MORE A WEEK - Check this box in the How Often column if you use this knowledge or skill at least once a week on your job (50 times per year).

ONCE OR MORE A MONTH - Check this box in the How Often column if you use this knowledge or skill at least once a month on your job (12 times per year).

ONCE OR MORE A YEAR - Check this box if you use this knowledge or skill at least once a year on your job (1 time per year).

Then check the box which shows if you understand the knowledge or skill indicated.

DO YOU UNDERSTAND HOW TO

YES - Check this box in the Do You Understand How To column if you understand this knowledge or understand how to do this skill.

NO - Check this box in the Do You Understand How To column if you do not understand this knowledge or do not understand how to do this skill.

Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

HOW DIFFICULT

VERY DIFFICULT - Check this box in the How Difficult column if this knowledge or skill is very hard to acquire.

FAIRLY DIFFICULT - Check this box in the How Difficult column if this knowledge or skill is fairly hard to acquire, but you are capable of it.

NOT DIFFICULT - Check this box in the How Difficult column if this knowledge or skill is easy to acquire.

Finally, check the box which shows how important to plant operation your having this knowledge or skill is.

HOW IMPORTANT

VERY IMPORTANT - Check this box in the How Important column if you must have this knowledge or skill for successful job performance.

FAIRLY IMPORTANT - Check this box in the How Important column if, all other things being equal, you having this knowledge or skill would probably have successful job performance before an employee or employer not having this knowledge or skill.

NOT IMPORTANT - Check this box in the How Important column if you do not actually need this knowledge or skill to have successful job performance.

Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check "never" only, and go on to the next skill or knowledge.

Please answer each question truthfully and carefully.

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								MANAGEMENT							
								Determine services needed							
								Identify sources for service							
								Compare quality and costs of services							
								Order services							
								Keep service department records							
								Determine consumable supplies needed							
								Identify sources of consumable supplies							
								Compare quality and costs of consumable supplies							
								Order consumable supplies							
								Record use of consummable supplies							
								Determine repair parts needed							
								Identify sources of repair parts							
								Compare quality and costs of repair parts							
								Order repair parts							
								Prepare specifications for bids							
								Prepare requisitions or purchase orders							
								Approve requisitions or purchase orders							
								Keep records of purchase orders							
								Check invoices for receipt of material ordered							
								Approve invoices for payment							
								Take inventories							
								Select standardization of equipment & material							
								Keep system operation records							
								Keep system maintenance records							
								Keep equipment maintenance records							
								Maintain operating records for State and regulatory agencies							
								Prepare daily and monthly reports							
								Prepare annual reports							
								Identify needed capital improvements							
								Review architectural and engineering plans							
								Work with consulting engineers to solve plant expansion or design problems							
								Promote plant expansion							
								Promote plant image							
								Prepare annual budgets							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Prepare long-range plans							
								Plan, implement and evaluate goal achievement							
								Identify staffing needs							
								Recruit employees							
								Select new employees							
								Orient new employees							
								Evaluate employee performance							
								Discipline employees							
								Discharge employees							
								Train employees							
								Keep records of employees							
								Personally oversee employee activity							
								Personally oversee plant activity							
								Fill out discharge permits							
								Encourage and promote professional growth (short courses, visits to other plants)							
								Maintain public relations with employees, government, industry and community							
								Negotiate salaries of others							
								Negotiate terms and conditions of employment of others							
								State or explain promotional policies							
								Identify needed operational changes							
								Establish work priorities							
								Assign responsibility to others							
								Prepare time sheets							
								Inform employees of their working schedule							
								Prepare payroll records							
								Perform utility accounting							
								Take meter readings							
								Compare water losses with water production							
								Determine power consumption							
								Compare expenditures to income							
								Determine manpower costs							
								Determine fuel and power costs							
								Determine maintenance and operation costs							
								Determine equipment costs							
								Determine training costs							
								Determine miscellaneous costs							
								Record utility accounting							
								Calculate water bills							
								File information, reports and records							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								HUMAN RELATIONS							
								Conduct plant tours							
								Prepare press releases							
								Inform public of upcoming problems (main flushing, service interruptions)							
								Respond to "outside" complaints							
								Use telephone							
								Write letters							
								Socialize with fellow employees							
								Deal with employee's grievances							
								Encourage employees to ask questions							
								Promote morale of subordinates							
								Communicate with superiors							
								Express problems or grievances							
								Ask questions when necessary							
								Establish oral communication							
								Promote morale of fellow workers							
								Belong to a community service club							
								Take pride in work performed							
								Maintain openmindedness to new methods							
								Communicate with subordinates							
								Communicate with fellow workers							
								Dress appropriately for the job							
								Exercise self-control in trying situations							
								Maintain honesty and integrity							
								Demonstrate initiative							
								Volunteer for work which is not described as a part of my job							
								Work with little or no supervision							
								Like my job							
								Use time efficiently							
								Work with women							
								Work with minority races							
								Work with handicapped persons							
								Work with persons of different religious denominations							
								Explain plant operations							

You have almost completed the section on management and human relations. If there are any knowledges or skills pertaining to management or human relations which we have overlooked, please list them below. Also, please check the box which shows how often you are required to use the knowledge or skill indicated.

Then check the box which shows if you understand the knowledge or skill indicated.

Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

Finally check the box which shows how important to plant operation your having this knowledge or skill is.

Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check "never" only and go on to the next skill or knowledge.

Then read the following directions:

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important

You do not have to complete every item in the remainder of survey. We only want to know about the areas in which you are working. If your job is in the area of:

Wastewater - turn to the green pages (Page 7).

Water - turn to the blue pages (Page 20).

WASTEWATER

Good. By turning to this page you indicated that your job is in the general area of wastewater (although it may include other areas). Now do the following:

If your job is primarily in the area of:

Wastewater Treatment - begin with the yellow pages (Page 10).

Wastewater Collection - (or both collection and treatment), begin below:

WASTEWATER COLLECTION

Below, and on the following green pages, are listed a number of knowledges and skills believed to be needed by a wastewater collection operator on the job.

For each item listed, please check the box which shows how often you are required to use the knowledge or skill indicated.

Then check the box which shows if you understand the knowledge or skill indicated.

Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

Finally check the box which shows how important to plant operation your having this knowledge or skill is.

Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check never only and go on to the next skill or knowledge.

Please answer each question truthfully and carefully.

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No	KEEP ON TRUCKING 	Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								OPERATIONS AND MAINTENANCE							
								Operate high velocity water jet							
								Operate power rodder							
								Operate bucket cleaning machine							
								Operate ball cleaning machine							
								Operate still camera (polaroid or 35 mm)							
								Operate TV inspection equipment							
								Operate TV grouting equipment							
								Use backhoe or other power trenching equipment							
								Open stopped main line							
								Open stopped lateral line							
								Repair of main line							
								Repair of lateral line							
								Open stopped storm sewer line							
								Repair storm sewer line							
								Operate sewer tapping machine							
								Remove cover from a manhole							
								Check manhole for oxygen deficient atmosphere							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Check manhole for toxic gases							
								Check manhole for explosive gases							
								Inspect manhole for obstructions							
								Inspect manhole for inflow							
								Inspect manhole for infiltration							
								Clean manhole							
								Repair manhole							
								Bypass manhole for repair work							
								Raise manhole rings							
								Raise manhole walls							
								Lower manhole walls							
								Install flow meter in manhole							
								Operate flow meter							
								Monitor and record readings from flow meter							
								Install prefabricated manhole							
								Smoke test manhole for infiltration and inflow							
								Smoke test sewer system for infiltration and inflow							
								Water pressure test sewers for I and I							
								Air pressure test sewers for I and I							
								Ventilate manholes for safe entry							
								Use breathing apparatus for safe manhole entry							
								Inspect sewer lines for obstruction and deterioration							
								Identify causes of obstruction or corrosion of sewer							
								Implement sewer use ordinance							
								Enforce sewer use ordinance							
								Monitor industrial discharges							
								Sample in sewer system							
								Inspect sewer construction jobs							
								Locate buried sewers and other pipes for excavation							
								Operate excavation equipment (backhoe dozer etc.)							
								Routine maintenance of sewer cleaning equipment							
								Maintain sewer construction equipment							
								Operate sewer system lift stations							
								Install lift stations							
								Use chemical sewer cleaning compounds							
								Update sewer system maps							
								Use sewer system maps and sewer profiles							
								Operate sewer system grit chambers							

WASTEWATER

Good. By turning to this page you indicated that your job is in the general area of wastewater (although it may include other areas). Now do the following:

If your job is primarily in the area of:

Wastewater Treatment - begin with the yellow pages (Page 10).

Wastewater Collection - (or both collection and treatment), begin below:

WASTEWATER COLLECTION

Below, and on the following green pages, are listed a number of knowledges and skills believed to be needed by a wastewater collection operator on the job.

For each item listed, please check the box which shows how often you are required to use the knowledge or skill indicated.

Then check the box which shows if you understand the knowledge or skill indicated.

Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

Finally check the box which shows how important to plant operation your having this knowledge or skill is.

Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check never only and go on to the next skill or knowledge.

Please answer each question truthfully and carefully.

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								OPERATIONS AND MAINTENANCE							
								Operate high velocity water jet							
								Operate power rodder							
								Operate bucket cleaning machine							
								Operate ball cleaning machine							
								Operate still camera (polaroid or 35 mm)							
								Operate TV inspection equipment							
								Operate TV grouting equipment							
								Use backhoe or other power trenching equipment							
								Open stopped main line							
								Open stopped lateral line							
								Repair of main line							
								Repair of lateral line							
								Open stopped storm sewer line							
								Repair storm sewer line							
								Operate sewer tapping machine							
								Remove cover from a manhole							
								Check manhole for oxygen deficient atmosphere							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Check manhole for toxic gases							
								Check manhole for explosive gases							
								Inspect manhole for obstructions							
								Inspect manhole for inflow							
								Inspect manhole for infiltration							
								Clean manhole							
								Repair manhole							
								Bypass manhole for repair work							
								Raise manhole rings							
								Raise manhole walls							
								Lower manhole walls							
								Install flow meter in manhole							
								Operate flow meter							
								Monitor and record readings from flow meter							
								Install prefabricated manhole							
								Smoke test manhole for infiltration and inflow							
								Smoke test sewer system for infiltration and inflow							
								Water pressure test sewers for I and I							
								Air pressure test sewers for I and I							
								Ventilate manholes for safe entry							
								Use breathing apparatus for safe manhole entry							
								Inspect sewer lines for obstruction and deterioration							
								Identify causes of obstruction or corrosion of sewer							
								Implement sewer use ordinance							
								Enforce sewer use ordinance							
								Monitor industrial discharges							
								Sample in sewer system							
								Inspect sewer construction jobs							
								Locate buried sewers and other pipes for excavation							
								Operate excavation equipment (backhoe dozer etc.)							
								Routine maintenance of sewer cleaning equipment							
								Maintain sewer construction equipment							
								Operate sewer system lift stations							
								Install lift stations							
								Use chemical sewer cleaning compounds							
								Update sewer system maps							
								Use sewer system maps and sewer profiles							
								Operate sewer system grit chambers							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Operate sewer system grease traps							
								Maintain special devices (grit chambers, grease traps etc.)							
								Use survey equipment (transit tape chain etc.)							
								Design sewer system additions (new laterals, mains etc.							
								Make house connections							
								Line old sewer pipes (plastic liners etc.)							
								Add chemicals for odor control							

You have almost completed the section on wastewater collection. If there are any knowledges or skills (used by you in wastewater collection which we have overlooked, please list them below. Also, please check the box which shows how often you are required to use the knowledge or skill indicated.

Then check the box which shows if you understand the knowledge or skill indicated.

Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

Finally check the box which shows how important to plant operation your having this knowledge or skill is.

Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check "never" only and go on to the next skill or knowledge.

Then read the following directions.

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important

Thank you. You have completed the survey section on wastewater collection. If your job involves wastewater collection only, please put this survey in the envelope provided and mail it to us, within one week. If your job involves wastewater treatment, water treatment or water distribution, see below.

If your job also involves:

1. Wastewater Treatment - continue by turning to the yellow pages (Page 10).
2. Water - but not wastewater treatment - continue by turning to the blue pages (Page 20)

SURVEY
NOW
MAIL
ME
US
MAIL

SURVEY
EXPRESS

KEEP ON TRUCKING

WASTEWATER TREATMENT

Below, and on the following yellow pages, are listed a number of knowledges and skills believed to be needed by a wastewater treatment operator on the job.

For each item listed, please check the box which shows how often you are required to use the knowledge or skill indicated.

Then check the box which shows if you understand the knowledge or skill indicated.

Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

Finally check the box which shows how important to plant operation your having this knowledge or skill is.

Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check "never" only and go on to the next skill or knowledge.

Please answer each question truthfully and carefully.

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No	KEEP ON TRUCKING SURVEY EXPRESS	Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								GENERAL OPERATION AND MAINTENANCE REST STOP 151 SKILLS & KNOWLEDGES							
								Operate screening removal equipment							
								Maintain screening removal equipment							
								Operate grit collection and removal equipment							
								Maintain grit collection & removal equipment							
								Operate flow control equipment							
								Maintain flow control equipment							
								Operate flow measurement equipment							
								Calculate organic loads							
								Calculate overflow rates and hydraulic loads							
								Maintain flow measurement equipment							
								Calibrate flow measure equipment							
								Monitor control panels, gauges, instruments for flow control and measurement							
								Maintain control panels, gauges, instruments for flow control and measurements							
								Inspect screening removal process for obstructions							
								Inspect grit removal process for obstructions							
								Inspect flow control and measurement process for obstructions and interferences							
								Operate valves and gates							
								Maintain valves and gates							
								Remove, disassemble and repair valves and gates							
								Remove, disassemble and repair screening process equipment							
								Remove, disassemble and repair grit process equipment							
								Remove, disassemble, and repair flow control equipment							
								Remove, disassemble and repair flow measurement equipment							
								Operate centrifugal pumps							
								Operate positive displacement pumps							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Inspect pumps for obstructions							
								Perform routine maintenance for pumps							
								Remove, disassemble and repair pumps							
								Operate backflow check valves							
								Inspect check valves for obstructions							
								Perform routine maintenance on check valves							
								Remove, disassemble and repair check valves							
								Operate primary settling basin							
								Perform routine maintenance on primary settling basin (collector drives, collectors weirs etc.)							
								Obtain samples from primary clarifier							
								Obtain samples of primary sludge							
								TRICKLING FILTER							
								Operate trickling filter							
								Monitor treatment performance of trickling filter							
								Perform routine maintenance on trickling filter							
								Remove, disassemble and repair of trickling filter distributors							
								Operate trickling filter, dosing chambers							
								Perform routine maintenance on dosing chambers							
								Operate secondary settling basin							
								Perform routine maintenance on secondary settling basin							
								Recirculate process sewage flow							
								Recirculate secondary underflow							
								ACTIVATED SLUDGE							
								Operate aeration equipment for desired treatment							
								Inspect meters, gauges and test results to determine required treatment							
								Monitor control panels for determining aeration action in waste							
								Inspect aerators							
								Inspect mixers							
								Operate mixers.							
								Pump primary sludge							
								Determine how much primary sludge to be pumped							
								Pump waste sludge							
								Pump return sludge							
								Determine how much waste sludge to be pumped							
								Determine how much return sludge to be pumped							
								Remove, disassemble and repair aerators							
								Remove, disassemble and repair mixers							

KEEP ON TRUCKING

SURVEY
EXPRESS

REST STOP
91 SKILLS &
KNOWLEDGES

How Often					Do You Understand How To		Knowledge or Skill	How Difficult			How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day	Yes	No		Very Difficult	Fairly Difficult	Not Difficult	Very Important	Fairly Important	Not Important
							CHLORINATION						
							Observe safety practices when handling chlorine						
							Change chlorine cylinders						
							Record chlorine cylinders identification numbers						
							Handle chlorine cylinders						
							Weigh and record chlorine cylinders						
							Inspect gauges on evaporator						
							Know operating principles of chlorine cylinders						
							Operate evaporator						
							Operate chlorinator						
							Know effect of chlorine on wastewater						
							Know effect of chlorine on air, metal, cloth and humans						
							Inspect pumps for proper operation						
							Inspect evaporator for proper operation (heat and pressure)						
							Inspect chlorinators for proper operation (pressure and leaks)						
							Repair chlorinator						
							Interpret lab data on chlorine dosage						
							Record the amount of chlorine used daily						
							Unload full chlorine cylinders and store on specified site						
							Store and load empty chlorine cylinders						
							GENERAL WASTEWATER TREATMENT--KNOWLEDGES & SKILLS						
							Know biological processes which occur in the wastewater treatment process						
							Know basic operating principles of the treatment equipment						
							Know the effects environmental conditions have on the treatment process						
							Use meters & gauges in treating wastewater						
							Read meters and gauges						
							Know the functions of meters and gauges in treating waste						
							Operate monitoring control panels in treating wastewater						
							Complete appropriate forms when checking conditions of treatment process						
							Check treatment equipment for proper functioning						
							Operate valves in treating and discharging wastewater						
							Know relationship of head and gate opening and flow of waste						
							Remove, disassemble, repair, reassemble and install treatment equipment						
							Observe safety practices in removing and installing treatment equipment						
							Select & use appropriate tools for removing, disassembling, repairing, reassembling & installing process equipment						

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Record water levels							
								Know basic operating principles of pumps							
								Operate pumps							
								Record operating output of pumps							
								Inspect pumps for proper operation							
								Monitor water levels in channels							
								REST STOP 52 SKILLS & KNOWLEDGES MAINTENANCE OF PUMPING STATIONS							
								Clean up around the pumping station							
								Operate sprinkling land application system							
								Replace burned out motors							
								Replace gaskets and seals							
								Inspect outfall for erosion & other damage							
								Grease & lubricate process equipment							
								Monitor dissolved oxygen levels in plant							
								LAGOON SYSTEMS							
								Operate a single cell pond system							
								Operate a two or more cell pond system							
								Perform routine maintenance on the ponds							
								Remove, disassemble and repair inlet & outlet structures on the pond system							
								Interpret lab data for pond system							
								DIGESTORS							
								Maintain gas sludge meters							
								Operate anaerobic digestors							
								Perform routine maintenance on digestors							
								Use digestor gas for heating, power generation or other uses in the treatment plant							
								Remove, disassemble and repair digestion process equipment							
								Interpret lab data on the digestor(s)							
								SLUDGE PROCESSING							
								Store sludge in holding tanks before processing							
								Operate a sludge thickening process prior to dewatering or digestion (dissolved air or gravity)							
								Perform routine maintenance on the thickening process							
								Remove, disassemble and repair sludge thickening process equipment							
								Interpret lab data on the thickening process							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Operate a type of chemical conditioning before dewatering the sludge							
								Perform routine maintenance on the conditioning process equipment							
								Remove, disassemble and repair the conditioning equipment							
								Operate vacuum filtration dewatering process equipment							
								Operate pressure filtration dewatering process equipment							
								Operate centrifugal dewatering process equipment							
								Operate drying beds or drying lagoons							
								Perform routine maintenance on sludge dewatering equipment							
								Remove, disassemble and repair sludge dewatering equipment							
								Clean drying beds							
								REST STOP 19 SKILLS & KNOWLEDGES SOLIDS DISPOSAL							
								Dispose of dry sludge at a land fill							
								Operate an incinerator or heat drier							
								Perform routine maintenance on incinerators							
								Operate a land spreading system for sludge							
								Perform routine maintenance on sludge spreading equipment (liquid or dry sludge)							
								Operate an aerobic digestion system							
								Perform routine maintenance on the aerobic digestion system							
								Operate a polishing pond after other means of treatment							
								ADVANCED TREATMENT							
								Operate an advanced physical treatment process such as filtration, aeration etc.							
								Operate an advanced chemical treatment process such as carbon absorption, coagulation etc.							
								MAINTENANCE, GENERAL							
								Perform maintenance operations in a shop							
								Repack pumps							
								Replace bearings and shafts							
								Lubricate equipment							
								MAINTAIN VEHICLES IN GOOD WORKING ORDER							
								Service vehicles							
								Repair and/or maintain vehicles							
								Operate trucks in a safe & careful manner							
								Clean and wash down workshop area							
								Maintain shift log and record meter and gauge readings							

SURVEY EXPRESS
PARK HERE
OFFICIAL REST STOP
GET SOME COFFEE

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								GENERAL SKILLS							
								Identify potential safety hazards on equipment							
								Identify various hand and power tools							
								Select appropriate hand and power tools for specific jobs							
								Store tools properly							
								Wear appropriate clothing							
								Provide proper ventilation when needed							
								Apply wood and metal preservatives							
								Clean and oil electric motors							
								Replace fuses							
								Replace electrical switches							
								Wire simple electrical circuit							
								Install electric motors							
								Reset circuit breakers							
								Repair broken electrical wires							
								Replace lighting fixtures							
								Replace electric motor belts and pulleys							
								Cut weeds and grass around buildings							
								Replace water pipes							
								Repair faucets							
								Replace valves in water system							
								GENERAL LABORATORY KNOWLEDGE AND SKILLS							
								Use safety precautions & procedures necessary to work in a laboratory							
								Use first aid techniques necessary to care for minor laboratory accidents							
								Properly handle hazardous materials							
								Add acid to water							
								Observe fire regulations regarding storage of explosive or inflammable materials							
								Use different types of sampling devices							
								Practice personal hygiene when handling wastewater							
								Wear protective clothing during the collection of a sample							
								Collect a representative sample							
								Prepare a diluted sample solution							
								Select an appropriate sampling location							
								Select representative sampling times							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Use monitoring wells							
								Know effects of effluent on ecology							
								Take & preserve a composite sample							
								Observe state and local laws regarding sampling requirements							
								Observe OSHA							
								Preserve samples							
								Prepare samples before testing							
								Operate the microscope							
								Record test results							
								Clean laboratory equipment							
								Sterilize laboratory equipment							
								Operate a sterilizer							
								COMMON SKILLS IN PERFORMING LABORATORY TESTS							
								Use various apparatus necessary to perform the tests							
								Use reagents where necessary							
								Prepare standard (normal) solution							
								Follow standard procedures for each test							
								Observe precautions in conducting each test							
								Make the necessary calculations							
								Use a lab notebook							
								Record results of each test							
								Order chemicals and equipment for tests							
								Dispose of waste chemicals							
								Use proper labeling in the laboratory							
								Store chemicals							
								TEST FOR ORGANIC CHARACTERISTICS OF:							
								Biochemical oxygen demand							
								Total organic carbon							
								Chemical oxygen demand							
								Total nitrogen							
								Total phosphorous							
								NOT MUCH FARTHER							
								TEST FOR CHLORINE							
								Use Hach or other kit type methods							
								Use an amperometric titration method							
								Use titrimetric methods							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Dificult	Not Difficult		Very Important	Fairly Important	Not Important
								OPERATE A:							
								pH meter							
								Analytical balance							
								Spectrophotometer							
								Specific Ion meter and electrodes							
								Microscope							
								DO meter							
								TEST FOR THE PHYSICAL QUALITY BY:							
								Turbidity							
								Color							
								TEST THE BIOLOGICAL QUALITY OF WATER BY:							
								Total coliform by membrane filter method							
								Total coliform by fermentation tube method							
								Fecal coliform							
								Fecal streptococci							
								THE LAST OF THE WASTEWATER TREATMENT! ALMOST THERE! TEST FOR THE CHEMICAL QUANTITY OF:							
								Arsenic							
								Cadmium							
								Chlorides							
								Chromium							
								Copper							
								Cyanide							
								Iron							
								Lead							
								Manganese							
								Mercury							
								Nitrate							
								Organic pesticides							
								Selenium							
								Silver							
								Sodium							
								Sulfate							
								Zinc							
								Phenols							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Impotant
								Filterable Residue (Total suspended solids)							
								Total Residue (Total solids)							
								Ammonia							
								pH Value							
								Phosphate							
								Alkalinity							
								Aluminum							
								Potassium							
								Residual Chlorine							
								Chlorine Demand							
								Volatile Solids							
								Volatile Acids							
								Total Acidity							

You have almost completed the section on wastewater treatment. If there are any knowledges or skills (used by you in wastewater treatment) which we have overlooked, please list them below. Also, please check the box which shows how often you are required to use the knowledge or skill indicated.

Then check the box which shows if you understand the knowledge or skill indicated.

Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

Finally check the box which shows how important to plant operation your having this knowledge or skill is.

Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check "never" only and go on to the next skill or knowledge.

Then read the following directions.

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important

Thank you. You have completed the appropriate survey section(s) on wastewater. If your job involves wastewater only, please put this survey in the envelope provided and mail it to us, within one week. If your job includes water, please turn to the blue pages (Page 20).

NOW
MAIL
ME

KEEP ON TRUCKING

SURVEY
EXPRESS

WATER

Good. By turning to this page you indicated that your job is in the general area of water (although it may include other areas). Now do the following:

If your job is primarily in the area of:

Water Distribution - turn to the pink pages (Page 26).

Water Treatment - (or both treatment and distribution) begin below:

WATER TREATMENT

Below, and on the following blue pages, are listed the knowledges and skills believed to be needed by a water treatment operator on the job.

For each item listed, please check the box which shows how often you are required to use the knowledge or skill indicated.

Then check the box which shows if you understand the knowledge or skill indicated.

Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

Finally check the box which shows how important to plant operation your having this knowledge or skill is.

Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check "never" only and go on to the next skill or knowledge.

Please answer each question truthfully and carefully.

KEEP ON TRUCKING
SURVEY EXPRESS
REST STOP
78 SKILLS &
KNOWLEDGES

How Often					Do You Understand How To		Knowledge or Skill	How Difficult			How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day	Yes	No		Very Difficult	Fairly Difficult	Not Difficult	Very Important	Fairly Important	Not Important
							WELLS						
							Perform water level test						
							Maintain water level records						
							Read flow meters						
							Operate electric well pumps						
							Operate auxiliary driven pumps						
							Perform routine high lift pump maintenance (change packing, grease)						
							Perform major pump repair (replace sleeve, bearings, etc.)						
							Maintain flow records						
							Operate plant control valves						
							Maintain electrical pump controls						
							STORAGE FACILITIES (RESERVOIRS, STANDPIPES, ELEVATED TANKS)						
							Maintain water level indicators						
							Maintain telemetry equipment						
							Maintain water level control equipment						
							Perform periodic inspection of storage unit						
							Clean storage unit						
							Operate cathodic protection devices						
							DIFFERENTIAL PRESSURE METERS (VENTURI & ORIFICE)						
							Perform routine maintenance						

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								REST STOP 61 SKILLS & KNOWLEDGES WATER TREATMENT							
								Operate rapid sand filters							
								Maintain rapid sand filters							
								Operate pressure filters							
								Maintain pressure filters							
								Operate sedimentation basins							
								Maintain sedimentation basins							
								Operate lime-soda ash softening systems							
								Maintain lime-soda ash softening equipment							
								Operate zeolite filters							
								Maintain zeolite filters							
								Operate aerators							
								Maintain aerators							
								Operate taste and odor removal equipment							
								Maintain taste and odor removal equipment							
								CHEMICAL EQUIPMENT							
								Add chemicals to feeders (fluoride, chlorine, carbon black etc.)							
								Determine proper dosage							
								Add dry chemical feeders							
								Adjust feeders for proper dosage							
								Maintain chemicals used record							
								Inventory chemicals							
								Perform periodic maintenance of feed equipment (dry, wet and slakers)							
								Repair chlorinator							
								Repair feed equipment							
								MAINTENANCE OF PLANT AND GROUNDS							
								Paint building (interior and equipment)							
								Maintain grounds (cutting grass, trimming trees)							
								REST STOP 36 SKILLS & KNOWLEDGES GENERAL LABORATORY/KNOWLEDGE AND SKILLS							
								Use safety precautions and procedures necessary to work in a laboratory							
								Use first aid techniques necessary to care for minor laboratory accidents							
								Properly handle hazardous materials							
								Add acid to water							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Observe fire regulations regarding storage of explosive or inflammable materials							
								Use different types of sampling devices							
								Practice personal hygiene when handling wastewater							
								Wear protective clothing during the collection of a sample							
								Collect a representative sample							
								Select an appropriate sampling location							
								Select representative sampling times							
								Use monitoring wells							
								Know effects of effluent on ecology							
								Collect and preserve a composite sample							
								Observe State and local laws regarding sampling requirements							
								Observe OSHA							
								Preserve samples							
								Prepare samples before testing							
								Operate the microscope							
								Record test results							
								Clean laboratory equipment							
								Sterilize laboratory equipment							
								Operate a sterilizer							
								Use a "jar test" for coagulation control							
								Make algae examinations on raw water							
								COMMON SKILLS IN PERFORMING LABORATORY TESTS							
								Use various apparatus necessary to perform test							
								Use reagents where necessary							
								Follow standard procedures for each test							
								Observe precautions in conducting each test							
								Make the necessary calculations							
								Keep a lab notebook							
								Record results of each test							
								Order chemicals and equipment for tests							
								Dispose of waste chemicals							
								Use proper labeling in the laboratory							
								Store chemicals							
								OFFICIAL REST STOP YOU DESERVE A BREAK!							
								TEST FOR ORGANIC CHARACTERISTICS OF:							
								Biochemical oxygen demand							
								Total organic carbon							

KEEP ON TRUCKING

SURVEY
EXPRESS

How Often					Do You Understand How To		Knowledge or Skill	How Difficult			How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day	Yes	No		Very Difficult	Fairly Difficult	Not Difficult	Very Important	Fairly Important	Not Important
							Chemical oxygen demand						
							Total nitrogen						
							Total phosphorous						
							TEST FOR CHLORINE:						
							Use Hach or other kit type methods						
							Use an amperometric titration method						
							Use titrimetric methods						
							OPERATE A:						
							pH meter						
							Analytical balance						
							Spectrophotometer						
							Specific Ion meter and electrodes						
							Microscope						
							DO meter						
							TEST FOR THE PHYSICAL QUALITY BY:						
							Taste						
							Odor						
							Temperature						
							Turbidity						
							Color						
							Conductance						
							TEST FOR RADIOACTIVITY OF:						
							Alpha activity						
							Beta activity						
							TEST THE BIOLOGICAL QUALITY OF WATER BY:						
							Total coliform by membrane filter method						
							Total coliform by fermentation tube method						
							Fecal coliform						
							Fecal streptococci						
							TEST FOR FLUORIDE						
							Use Hach or other kit type methods						
							Use a fluoride ion electrode						

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Use EPA or APHA standard methods							
								TEST FOR NITRATE							
								Use Hach or other kit type methods							
								Use a nitrate ion electrode							
								Use brucine colormetric method							
								Use cadmium reduction method							
								ONLY ONE LIST TO GO FOR WATER TREATMENT! TEST FOR THE CHEMICAL QUANTITY OF							
								Alkyl Benzene Sulfonates (ABS)							
								Arsenic							
								Barium							
								Cadmium							
								Chlorides							
								Chromium							
								Copper							
								Cyanide							
								Iron							
								Lead							
								Manganese							
								Mercury							
								Nitrate							
								Organic Pesticides							
								Carbon Chloroform Extractables (CCE)							
								Selenium							
								Silver							
								Sodium							
								Sulfate							
								Zinc							
								Phenols							
								Filtrable Residue (Total suspended solids)							
								Total Residue (Total solids)							
								Ammonia							
								pH value							
								Hardness							
								Phosphate							
								Alkalinity							
								Aluminum							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Potassium							
								Residual Chlorine							
								Chlorine Demand							

You have almost completed the section on water treatment. If there are any knowledges or skills (used by you in water treatment), which we have overlooked, please list them below. Also, please check the box which shows how often you are required to use the knowledge or skill indicated.

Then check the box which shows if you understand the knowledge or skill indicated.

Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

Finally check the box which shows how important to plant operation your having this knowledge or skill is.

Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check "never" only and go on to the next skill or knowledge.

Then read the following directions.

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important

Thank you. You have completed the survey section on water treatment. If your job does not involve water distribution, please put this survey in the envelope and mail it to us, within one week. If your job includes water distribution, please complete the final section (pink pages) beginning on Page 26 .

NOW
MAIL
ME

KEEP ON TRUCKING

SURVEY
EXPRESS

WATER DISTRIBUTION

Below, and on the following pink pages, are listed a number of knowledges and skills believed to be needed by a water distribution operator on the job.

For each item listed, please check the box which shows how often you are required to use the knowledge or skill indicated.

Then check the box which shows if you understand the knowledge or skill indicated.

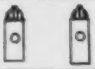
Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

Finally check the box which shows how important to plant operation your having this knowledge or skill is.

Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check "never" only and go on to the next skill or knowledge.

Please answer each question truthfully and carefully.

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No	KEEP ON TRUCKING SURVEY EXPRESS	Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								 WELLS							
								Perform water level test							
								Maintain water level records							
								Read flow meters							
								Operate electric well pumps							
								Operate auxiliary driven pumps							
								Perform routine high lift pump maintenance (change packing, grease)							
								Perform major pump repair (replace sleeve, bearings etc.)							
								Maintain flow records							
								Operate plant control valves							
								Maintain electrical pump controls							
								WELCOME TO WATERMAIN POP. 13 SKILLS & KNOWLEDGES WATER MAINS							
								Perform hydrostatic leakage tests							
								Disinfect new installation							
								Maintain main location records							
								Inspect construction							
								Locate leaks							
								Excavate trench for main repair							
								Use backhoe or other power trenching equipment							
								Install repair clamps or sleeves							
								Prepare or repair lead joints							
								Maintain leak records							
								Thaw frozen main with electric welder							
								Maintain pressure relief valves							
								Maintain vacuum relief valves							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How **Important**		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								SYSTEM VALVES							
								Determine type of valves							
								Determine location of new valves							
								Install valves							
								Exercise valves periodically							
								Repair defective valves							
								Maintain valve location records							
								Maintain valve repair records							
								Install tapping in valves							
								HYDRANTS 							
								Determine type of hydrant							
								Determine hydrant location							
								Install new or replacement hydrants							
								Perform periodic inspection							
								Perform periodic flushing							
								Repair defective or damaged hydrants							
								Maintain hydrant location records							
								Maintain hydrant repair records							
								Perform flow and pressure tests							
								SERVICE CONNECTIONS							
								Determine size and location of services							
								Perform tapping operation							
								Install corporation stops							
								Install service lateral							
								Install curb stops							
								Inspect installation of service connection							
								Locate leaks in service							
								Maintain service location records							
								Maintain service repair records							
								Thaw frozen services							
								STORAGE FACILITIES (RESERVOIRS, STANDPIPES, ELEVATED TANKS)							
								Maintain water level indicators							
								Maintain telemetry equipment							

SERVICE
TRUCK

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								Maintain water level control equipment							
								Perform periodic inspection of storage unit							
								Clean storage unit							
								Operate cathodic protection devices							
								Maintain cathodic protection devices							
								MEASUREMENT POSITIVE DISPLACEMENT METERS							
								Install customer water meters							
								Read customer water meters							
								Perform periodic accuracy tests							
								Repair utility owned water meters							
								Maintain meter records							
								DIFFERENTIAL PRESSURE METERS (VENTURI & ORIFICE)							
								Perform routine maintenance							
								WATER TREATMENT							
								Maintain lime-soda ash softening equipment							
								Operate zeolite filters							
								Maintain zeolite filters							
								Operate aerators							
								Maintain aerators							
								Operate taste and odor removal equipment							
								Maintain taste and odor removal equipment							
								CHEMICAL TREATMENT							
								Add chemicals to feeders (fluoride, chlorine, carbon black etc.)							
								Determine proper dosage							
								Add dry chemical feeders							
								Adjust feeders for proper dosage							
								Maintain chemicals used record							
								Perform periodic maintenance of feed equipment (dry, wet & slakers)							
								Perform repairs of feed equipment							
								MAINTENANCE							
								Paint building (interior & equipment)							
								Maintain grounds (cutting grass, trimming trees)							

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important
								LABORATORY							
								Collect a representative sample							
								Select an appropriate sampling location							
								Select representative sampling times							
								Test for chlorine using Hach or other kit-type methods							
								Test for chlorine using amperometric titration method							
								Test for chlorine using titrimetric methods							

You have almost completed the section on water distribution. If there are any knowledges or skills (used by you in water distribution) which we have overlooked, please list them below. Also, please check the box which shows how often you are required to use the knowledge or skill indicated.

Then check the box which shows if you understand the knowledge or skill indicated.

Afterwards check the box which shows how difficult it is to possess the knowledge or skill indicated to successfully perform the task.

Finally check the box which shows how important to plant operation your having this knowledge or skill is.

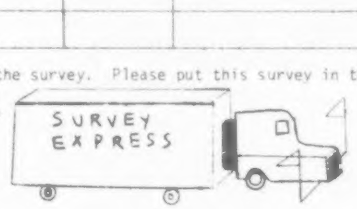
Please be sure to check each of the 4 columns for each skill unless you never use the knowledge or skill. If you never use the knowledge or skill on your job, check "never" only and go on to the next skill or knowledge.

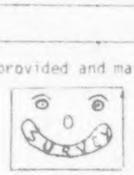
Then read the following directions.

How Often						Do You Understand How To		Knowledge or Skill	How Difficult				How Important		
Never	Once or More a Year	Once or More a Month	Once or More a Week	Once or More a Day		Yes	No		Very Difficult	Fairly Difficult	Not Difficult		Very Important	Fairly Important	Not Important

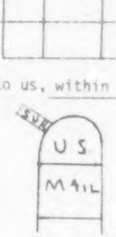
Thank you. You have completed the survey. Please put this survey in the envelope provided and mail it to us, within one week.

WELL OPERATOR THAT'S A BIG 10-4,
CAUSE THAT'S ALL THERE IS,
THERE AIN'T NO MORE.





NOW
MAIL
ME



Survey Findings

The following pages contain data which identifies the percent of grade levels I, II, and III operators who perform the tasks listed in each of the six sections of the survey. A summary of the findings for each section is included at the beginning of that section.

Rationale

The Kirkwood Community College Water and Wastewater Training Center is in the process of developing a competency based program for training certified water and wastewater operators. The purpose of this survey is to establish a list of the tasks which existing water/wastewater treatment plant operators perform in Iowa. Those tasks which grade level I, II and III operators identified in the survey as being tasks performed on a regular basis, serve as the competencies to be taught in the water/wastewater training program at Kirkwood.

Objectives

The overall purpose of this project is to develop a competency based curriculum to accommodate a part-time program and a full-time program in water and wastewater treatment plant operations.

The specific objectives include:

1. To identify competencies levels necessary to enter as a grade two plant operator.
2. To establish a competency based guide for developing a program which is flexible enough to accommodate a part-time and full-time students.
3. To develop competency based curriculum guides that are flexible enough to be adopted to group or self-paced instruction methodology.
4. To examine and refine the existing curriculum structure and materials.

Format

The survey consists of six general areas: (1) Management, (2) Human Relations, (3) Wastewater Collection, (4) Wastewater Treatment, (5) Water Treatment, and (6) Water Distribution. Each of the six areas contains an inclusive comprehensive number of tasks performed in that area. Operators were asked to respond to four questions about each task. These questions were:

1. Identify the frequency which each indicated tasks were performed.
2. Identify the importance of each task.
3. Identify the tasks which they could perform.
4. Identify the tasks which were seen as necessary.

Population

Approximately 231 operators responded to this survey. Many operators hold certificates and jobs in both water and wastewater treatment plant operation. This created a total of 831 respondents for the survey. A detailed numerical description of the number of responses made by grade level and plant task areas can be found on page

Method

Individual responses to the frequency section of the survey were averaged by grade level for each task. Averages were established for grade level I, II, and III operators for each task of the survey. This data was compared to a parallel form on which individual instructors identified survey tasks for which they had teaching responsibility in the existing program.

Data was gathered for all courses and from all instructors. The tasks done by the grade II operators were compared to tasks taught in the existing program. The revised program evolved from a group of instructors meetings. The following pages summarize the findings for each job area identified in the survey.

Findings

Because the findings of this survey are so extensive, the data presented in this report represents only the findings for the first (of four) questions identified previously (i.e. identification of the frequency which operators performed each of the tasks). This data indicates what percent of the operators (by their grade level) perform each task listed at least once a year or more.

Survey

A copy of the survey form is included at the end of the findings section.

The following table identifies the total number of operators who responded in each of the six areas of work surveyed. Operators are goruped by operator grade level, job area employed and total operators. Some operators hold certification and jobs in both water and wastewater, which caused more responses than identified in the 239 surveys returned.

BREAKDOWN OF OPERATOR POPULATION

	Grade I	Grade II	Grade III	Total
Management	n = 73	n = 95	n = 40	N = 208
Human Relations	64	93	41	N = 198
Total Responses	N_1 = 137	N_2 = 188	N_3 = 81	N_n = 406
Wastewater Collection	32	43	13	N = 88
Wastewater Treatment	31	55	27	N = 113
Total Responses	N_1 = 63	N_2 = 98	N_3 = 40	N_n = 201
Water Treatment	48	56	17	N = 121
Water Distribution	42	48	13	N = 103
Total Responses	N_1 = 90	N_2 = 104	N_3 = 30	N_n = 224
Totals by grade levels	N_1 = 290	N_2 = 390	N_3 = 151	N_n = 831

N = Total number of operators responding by job area

n = Number of operators within each individual job levels and grade level.

$N_{1, 2, 3}$ = Sub area totals by operator grade level and grade level.

N_n = Total number of operators responding to a job area and total survey.

PLANT MANAGEMENT

In the plant management section of the survey identified 73 potential tasks. Ninety five (95) grade level II operators responding to the survey indicated that 60 of the tasks were actually performed in Iowa plants by 25% or more of the grade level II operators.

The water/wastewater plant training center at Kirkwood initially addressed (54 tasks) 74% of the original 73 tasks and 87% of the 60 tasks identified by grade II operators.

The revised program will include 54 of the 60 tasks which grade II operators identified as being significant tasks. That means the program will teach 90% of the 60 tasks in its management courses.

Six additional tasks were included in the revised program because some grade I and II operators are performing superintendent functions. The center is training grade level II operators and not superintendents.

Question Number	MANAGEMENT	Operator Grade Level		
		I	II	III
1	Determine services needed	70	81	82%
2	Identify sources for service	60	74	74
3	Compare quality and costs of services	50	63	63
4	Order services	55	70	64
5	Keep service department records	50	69	64
6	Determine consumable supplies needed	59	78	68
7	Identify sources of consumable supplies	54	65	59
8	Compare quality and costs of consumable supplies	52	60	53
9	Order consumable supplies needed	67	72	70
10	Record use of consummable supplies	39	64	39
11	Determine repair parts needed	71	84	90
12	Identify sources of repair parts	69	75	31
13	Compare quality and costs of repair parts	50	63	49
14	Order repair parts	67	69	72
15	Prepare specifications for bids	13	17	10
16	Prepare requisitions or purchase orders	33	52	46
17	Approve requisitions or purchase orders	25	38	16
18	Keep records of purchase orders	36	50	41
19	Check invoices for receipt of material ordered	62	72	72
20	Approve invoices for payment	39	39	36
21	Take inventories	55	71	60
22	Select standardization of equipment & material	31	48	41
23	Keep system operation records	70	80	78
24	Keep system maintenance records	60	72	72
25	Keep equipment maintenance records	50	69	72

Question Number	MANAGEMENT	Operator Grade Level		
		I	II	III
26	Maintain operating records for State and regulatory agencies	71	74	60
27	Prepare daily and monthly reports	73	77	80
28	Prepare annual reports	47	45	28
29	Identify needed capital improvements	42	48	38
30	Review architectural and engineering plans	32	40	38
31	Work with consulting engineers to solve plant expansion or design problems	38	50	49
32	Promote plant expansion	31	45	33
33	Promote plant image	56	62	58
34	Prepare annual budgets	34	27	19
35	Prepare long-range plans	31	27	16
36	Plan, implement and evaluate goal achievement	27	30	28
37	Identify staffing needs	30	31	33
38	Recruit employees	28	26	15
39	Select new employees	28	23	23
40	Orient new employees	37	44	56
41	Evaluate employee performance	33	40	45
42	Discipline employees	28	22	28
43	Discharge employees	20	18	5
44	Train employees	41	56	64
45	Keep records of employees	25	27	36
46	Personally oversee employee activity	35	53	61
47	Personally oversee plant activity	49	61	77
48	Fill out discharge permits	22	32	31
49	Encourage and promote professional growth (short courses, visits to other plants)	34	57	61
50	Maintain public relations with employees, government, industry and community	46	62	67

Question Number	MANAGEMENT	Operator Grade Level			
		I	II	III	
51	Negotiate salaries of others	16	24	23	
52	Negotiate terms and conditions of employment of others	21	19	31	
53	State or explain promotional policies	18	27	29	
54	Identify needed operational changes	46	55	66	
55	Establish work priorities	41	56	75	
56	Assign responsibility to others	38	58	58	
57	Prepare time sheets	28	40	54	
58	Inform employees of their working schedule	31	35	48	
59	Prepare payroll records	16	14	14	
60	Perform utility accounting	11	12	11	
61	Take meter readings	56	64	60	
62	Compare water losses with water production	40	37	28	
63	Determine power consumption	27	35	36	
64	Compare expenditures to income	21	25	16	
65	Determine manpower costs	17	20	18	
66	Determine fuel and power costs	20	23	14	
67	Determine maintenance and operation costs	29	30	26	
68	Determine equipment costs	25	31	19	
69	Determine training costs	13	18	20	
70	Determine miscellaneous costs	27	30	18	
71	Record utility accounting	14	9	0	
72	Calculate water bills	17	13	0	
73	File information, reports and records	57	64	63	

HUMAN RELATIONS

The human relations sections of the survey listed a total of 33 potential tasks. The 93 responding grade II operators identified 31 of the 33 tasks as being ones performed by more than 25% of the operators on a regular basis. Thirteen of the 31 tasks are communication skills developed outside of the department and taught in the program to suit the tasks performed by operators.

The original and revised programs contain 18 tasks not taught in communications and complimented the 13 communication tasks.

The difference will occur in the efficiency of the systematic curriculum of the revised program over the former program. Also, more coordination will exist between departments on the kinds of tasks to be taught.

Question Number	HUMAN RELATIONS	Operator Grade Level		
		I	II	III
1	Conduct plant tours	46	62%	68
2	Prepare press releases	16	18	10
3	Inform public of upcoming problems (main flushing, service interruptions)	46	53	29
4	Respond to "outside" complaints	75	77	73
5	Use telephone	87	96	95
6	Write letters	60	57	47
7	Socialize with fellow employees	63	78	64
8	Deal with employee's grievances	36	51	39
9	Encourage employees to ask questions	48	67	66
10	Promote morale of subordinates	41	59	54
11	Communicate with superiors	75	95	85
12	Express problems or grievances	70	81	78
13	Ask questions when necessary	86	92	80
14	Establish oral communication	64	82	78
15	Promote morale of fellow workers	47	68	66
16	Belong to a community service club	48	43	78
17	Take pride in work performed	89	89	80
18	Maintain openmindedness to new methods	75	85	76
19	Communicate with subordinates	53	75	76
20	Communicate with fellow workers	58	87	85
21	Dress appropriately for the job	84	89	85
22	Exercise self-control in trying situations	84	89	80
23	Maintain honesty and integrity	86	84	83
24	Demonstrate initiative	75	83	83
25	Volunteer for work which is not described as a part of my job	83	80	73

Question Number	HUMAN RELATIONS	Operator Grade Level			
		I	II	III	
26	Work with little or no supervision	87	90	88	
27	Like my job	78	78	83	
28	Use time efficiently	81	85	85	
29	Work with women	52	52	39	
30	Work with minority races	28	34	27	
31	Work with handicapped persons	23	17	19	
32	Work with persons of different religious denominations	62	80	83	
33	Explain plant operations	80	85	80	

WASTEWATER COLLECTION

There were a total of 62 tasks listed in the wastewater collection section of the survey. The 43 grade II operators identified 40 tasks of the 62 as ones performed by at least 25% or more of the operator on a regular basis.

The original wastewater collection program (1974 to 1978) included 45 (73%) of the 62 tasks listed in the wastewater collection section and 32 (80%) of the 40 tasks identified as valid operator tasks.

The revised program will include 37 or 93% of the 40 valid operator tasks within the department. Three (3) additional tasks will be taught outside of the department. Each of the 3 tasks are one of the 40 valid operator tasks. Two additional tasks will be included in the program because of new requirements.

The addition courses are:

29 p. 7, # 38 p. 7

The revised wastewater collection program will be more streamlined in design than the original by 11%. This means a reduction of 8 tasks of little plant operation significance to the learner. Also the number program skills proficiency level has increased by at least 20% over the former program.

Question Number	WASTEWATER COLLECTION	Operator Grade Level			
		I	II	III	
1	Operate high velocity water jet	9%	33%	23	
2	Operate power rodder	22	51	53	
3	Operate bucket cleaning machine	3	15	23	
4	Operate ball cleaning machine	0	4	0	
5	Operate still camera (polaroid or 35 mm)	22	21	31	
6	Operate TV inspection equipment	0	2	0	
7	Operate TV grouting equipment	0	2	0	
8	Use backhoe or other power trenching equipment	37	48	31	
9	Open stopped main line	53	72	62	
10	Open stopped lateral line	43	60	62	
11	Repair of main line	43	65	62	
12	Repair of lateral line	44	60	54	
13	Open stopped storm sewer line	40	56	46	
14	Repair storm sewer line	80	41	31	
15	Operate sewer tapping machine	9	21	0	
16	Remove cover from a manhole	81	84	92	
17	Check manhole for oxygen deficient atmosphere	21	42	24	
18	Check manhole for toxic gases	25	32	38	
19	Check manhole for explosive gases	18	32	30	
20	Inspect manhole for obstructions	72	79	77	
21	Inspect manhole for inflow	69	79	69	
22	Inspect manhole for infiltration	66	74	62	
23	Clean manhole	66	72	69	
24	Repair manhole	40	56	47	
25	Bypass manhole for repair work	3	23	23	

Question Number	WASTEWATER COLLECTION	Operator Grade Level			
		I	II	III	
26	Raise manhole rings	44	54	62%	
27	Raise manhole walls	28	32	46	
28	Lower manhole walls	16	18	39	
29	Install flow meter in manhole	9	16	23	
30	Operate flow meter	15	33	53	
31	Monitor and record readings from flow meter	22	33	77	
32	Install prefabricated mamhole	6	25	23	
33	Smoke test manhole for infiltration and inflow	9	19	23	
34	Smoke test sewer system for infiltration and inflow	6	14	23	
35	Water pressure test sewers for I and I	0	5	8	
36	Air pressure test sewers for I and I	3	5	0	
37	Ventilate manholes for safe entry	43	54	38	
38	Use breathing apparatus for safe manhole entry	12	18	0	
39	Inspect sewer lines for obstruction and deterioration	34	51	61	
40	Identify causes of obstruction or corrosion of sewer	19	39	31	
41	Implement sewer use ordinance	19	22	23	
42	Enforce sewer use ordinance	31	26	23	
43	Monitor industrial discharges	21	37	54	
44	Sample in sewer system	56	73	69	
45	Inspect sewer construction jobs	40	48	45	
46	Locate buried sewers and other pipes for excavation	50	70	46	
47	Operate excavation equipment (backhoe dozer etc.)	37	44	15	
48	Routine maintenance of sewer cleaning equipment	28	55	69	
49	Maintain sewer construction equipment	18	33	23	
50	Operate sewer system lift stations	57	70	85	

Question Number	WASTEWATER COLLECTION	Operator Grade Level		
		I	II	III
51	Install lift stations	9	19	8%
52	Use chemical sewer cleaning compounds	44	65	41
53	Update sewer system maps	25	49	62
54	Use sewer system maps and sewer profiles	56	61	47
55	Operate sewer system grit chambers	15	56	54
56	Operate sewer system grease traps	9	18	69
57	Maintain special devices (grit chambers, grease traps etc.)	9	37	31
58	Use survey equipment (transit tape chain etc.)	13	18	62
59	Design sewer system additions (new laterals, mains etc.	6	14	8
60	Make house connections	9	14	8
61	Line old sewer pipes (plastic liners etc.)	0	7	0
62	Add chemicals for odor control	22	78	54

WASTEWATER TREATMENT

The wastewater treatment section of the survey contained 258 possible tasks. The responding 55 grade II operators identified 164 tasks of the 258 tasks as being tasks performed by at least 25% of the operators at least once a year.

The original program of 1974 - 1978 included 227 (88%) of the 258 tasks in the wastewater treatment section of the survey. The original program addressed 148 (89%) of the 164 tasks identified by operators as being regular tasks.

The revised program will consist of 162 (99%) of the 164 tasks identified by operators. One (1) additional task (# p.) will be taught outside of the department but in the program.

The revised program will accomplish two improvements over the former program: (1) It will narrow the large number of tasks to be taught/learned by 65 tasks; and (2) Increase the efficiency level of the program by at least 10%.

Question Number	WASTEWATER TREATMENT GENERAL OPERATION AND MAINTENANCE	Operator Grade Level I	II	III	
1	Operate screening removal equipment	31%	69%	85%	
2	Maintain screening removal equipment	25	64	70	
3	Operate grit collection and removal equipment	20	58	81	
4	Maintain grit collection & removal equipment	16	49	74	
5	Operate flow control equipment	46	69	70	
6	Maintain flow control equipment	42	57	56	
7	Operate flow measurement equipment	71	71	89	
8	Calculate organic loads	39	58	70	
9	Calculate overflow rates and hydraulic loads	22	38	52	
10	Maintain flow measurement equipment	35	48	78	
11	Calibrate flow measure equipment	22	36	48	
12	Monitor control panels, gauges, instruments for flow control and measurement	48	67	81	
13	Maintain control panels, gauges, instruments for flow control and measurements	35	37	63	
14	Inspect screening removal process for obstructions	25	69	89	
15	Inspect grit removal process for obstructions	19	65	81	
16	Inspect flow control and measurement process for obstructions and interferences	39	60	67	
17	Operate valves and gates	84	91	93	
18	Maintain valves and gates	61	76	78	
19	Remove, disassemble and repair valves and gates	32	62	59	
20	Remove, disassemble and repair screening process equipment	10	38	55	
21	Remove, disassemble and repair grit process equipment	3	35	44	
22	Remove, disassemble, and repair flow control equipment	19	33	36	
23	Remove, disassemble and repair flow measurement equipment	19	33	44	
24	Operate centrifugal pumps	64	80	85	
25	Operate positive displacement pumps	25	46	70	

WASTEWATER TREATMENT

Question Number	GENERAL OPERATION AND MAINTENANCE	Operator Grade Level I	Operator Grade Level II	Operator Grade Level III
26	Inspect pumps for obstructions	61	80	85
27	Perform routine maintenance for pumps	55	82	89
28	Remove, disassemble and repair pumps	42	64	70
29	Operate backflow check valves	55	75	67
30	Inspect check valves for obstructions	61	75	70
31	Perform routine maintenance on check valves	55	67	59
32	Remove, disassemble and repair check valves	42	60	56
33	Operate primary settling basin	26	67	78
34	Perform routine maintenance on primary settling basin (collector drives, collectors weirs etc.)	15	60	74
35	Obtain samples from primary clarifier	35	63	74
36	Obtain samples of primary sludge	29	53	56
	TRICKLING FILTER			
37	Operate trickling filter	25	56%	78%
38	Monitor treatment performance of trickling filter	19	47	63
39	Perform routine maintenance on trickling filter	22	53	71
40	Remove, disassemble and repair of trickling filter distributors	10	25	45
41	Operate trickling filter, dosing chambers	13	28	40
42	Perform routine maintenance on dosing chambers	16	23	30
43	Operate secondary settling basin	25	57	81
44	Perform routine maintenance on secondary settling basin	19	49	70
45	Recirculate process sewage flow	22	46	74
46	Recirculate secondary underflow	16	43	67

Question Number	WASTEWATER TREATMENT	Operator Grade Level I	Operator Grade Level II	Operator Grade Level III
	ACTIVATED SLUDGE			
47	Operate aeration equipment for desired treatment	6	20	19%
48	Inspect meters, gauges and test results to determine required treatment	6	22	19
49	Monitor control panels for determining aeration action in waste	3	18	15
50	Inspect aerators	6	20	15
51	Inspect mixers	2	11	7
52	Operate mixers	6	11	11
53	Pump primary sludge	6	22	11
54	Determine how much primary sludge to be pumped	6	16	11
55	Pump waste sludge	6	23	19
56	Pump return sludge	6	22	19
57	Determine how much waste sludge to be pumped	6	21	19
58	Determine how much return sludge to be pumped	6	17	15
59	Remove, disassemble and repair aerators	0	12	11
60	Remove, disassemble and repair mixers	3	11	7
	CHLORINATION			
61	Observe safety practices when handling chlorine	19%	33%	30%
62	Change chlorine cylinders	16	30	27
63	Record chlorine cylinders identification numbers	9	22	15
64	Handle chlorine cylinders	12	33	26
65	Weigh and record chlorine cylinders	15	25	26
66	Inspect gauges on evaporator	6	26	26
67	Know operating principles of chlorine cylinders	12	22	30
68	Operate evaporator	6	11	15
69	Operate chlorinator	9	27	26

WASTEWATER TREATMENT

Question Number	CHLORINATION	Operator Grade Level I	Operator Grade Level II	Operator Grade Level III
70	Know effect of chlorine on wastewater	19	22	30
71	Know effect of chlorine on air, metal, cloth and humans	22	25	34
72	Inspect pumps for proper operation	19	31	33
73	Inspect evaporator for proper operation (heat and pressure)	6	13	19
74	Inspect chlorinators for proper operation (pressure and leaks)	12	28	31
75	Repair chlorinator	12	16	14
76	Interpret lab data on chlorine dosage	19	22	22
77	Record the amount of chlorine used daily	16	32	29
78	Unload full chlorine cylinders and store on specified site	12	28	26
79	Store and load empty chlorine cylinders	15	26	26

GENERAL WASTEWATER TREATMENT--KNOWLEDGE & SKILLS

80	Know biological processes which occur in the wastewater treatment process	65	65%	85%
81	Know basic operating principles of the treatment equipment	65	62	85
82	Know the effects environmental conditions have on the treatment process	68	64	78
83	Use meters & gauges in treating wastewater	49	71	81
84	Read meters and gauges	61	76	85
85	Know the functions of meters and gauges in treating waste	52	64	74
86	Operate monitoring control panels in treating wastewater	35	60	67
87	Complete appropriate forms when checking conditions of treatment process	52	58	78
88	Check treatment equipment for proper functioning	61	69	89
89	Operate valves in treating and discharging wastewater	45	73	85
90	Know relationship of head and gate opening and flow of waste	38	51	56
91	Remove, disassemble, repair, reassemble and install treatment equipment	29	45	67
92	Observe safety practices in removing and installing treatment equipment	36	55	70

Question Number	WASTEWATER TREATMENT GENERAL WASTEWATER TREATMENT--KNOWLEDGE & SKILLS	Operator Grade Level		
		I	II	III
93	Select & use appropriate tools for removing, disassembling, repairing, reassembling & installing process equipment	38	52	64
94	Record water levels	55	65	56
95	Know basic operating principles of pumps	58	71	74
96	Operate pumps	65	82	89
97	Record operating output of pumps	51	65	37
98	Inspect pumps for proper operation	61	71	85
99	Monitor water levels in channels	34	58	45
	MAINTENANCE OF PUMPING STATIONS			
100	Clean up around the pumping station	61%	71%	64%
101	Operate sprinkling land application system	9	8	14
102	Replace burned out motors	36	40	49
103	Replace gaskets and seals	48	55	48
104	Inspect outfall for erosion & other damages	35	55	52
105	Grease & lubricate process equipment	54	69	64
106	Monitor dissolved oxygen levels in plant	38	58	67
	LAGOON SYSTEMS			
107	Operate a single cell pond system	16%	8%	11%
108	Operate a two or more cell pond system	45	23	19
109	Perform routine maintenance on the ponds	41	22	22
110	Remove, disassemble and repair inlet & outlet structures on the pond system	25	9	7
111	Interpret lab data for pond system	38	16	22

Question Number	WASTEWATER TREATMENT DIGESTORS	Operator Grade Level		
		I	II	III
112	Maintain gas sludge meters	3	31	44%
113	Operate anaerobic digestors	19	46	63
114	Perform routine maintenance on digestors	16	39	66
115	Use digestor gas for heating, power generation or other uses in the treatment plant	9	27	52
116	Remove, disassemble and repair digestion process equipment	3	29	40
117	Interpret lab data on the digester(s)	19	24	67
	SLUDGE PROCESSING			
118	Store sludge in holding tanks before processing	9%	21%	23%
119	Operate a sludge thickening process prior to dewatering or digestion (dissolved air or gravity)	3	9	15
120	Perform routine maintenance on the thickening process	3	7	11
121	Remove, disassemble and repair sludge thickening process equipment	3	4	4
122	Interpret lab data on the thickening process	12	4	7
123	Operate a type of chemical conditioning before dewatering the sludge	3	9	4
124	Perform routine maintenance on the conditioning process equipment	3	6	4
125	Remove, disassemble and repair the conditioning equipment	0	4	4
126	Operate vacuum filtration dewatering process equipment	0	8	8
127	Operate pressure filtration dewatering process equipment	0	6	4
128	Operate centrifugal dewatering process equipment	0	0	0
129	Operate drying beds or drying lagoons	12	34	34
130	Perform routine maintenance on sludge dewatering equipment	0	15	12
131	Remove, disassemble and repair sludge dewatering equipment	0	7	4
132	Clean drying beds	9	37	34

Question Number	WASTEWATER TREATMENT SOLIDS DISPOSAL	Operator Grade Level I	 II	 III
133	Dispose of dry sludge at a landfill	9	31	14%
134	Operate an incinerator or heat drier	0	4	7
135	Perform routine maintenance on incinerators	0	4	4
136	Operate a land spreading system for sludge	16	38	60
137	Perform routine maintenance on sludge spreading equipment (liquid or dry sludge)	12	32	49
138	Operate an aerobic digestion system	3	17	30
139	Perform routine maintenance on the aerobic digestion system	3	17	22
140	Operate a polishing pond after other means of treatment	3	10	15
	ADVANCED TREATMENT			
141	Operate an advanced physical treatment process such as filtration, aeration etc.	6%	17%	19%
142	Operate an advanced chemical treatment process such as carbon absorption, coagulation etc.	0	4	4
	MAINTENANCE, GENERAL			
143	Perform maintenance operations in a shop	26%	54%	75%
144	Repack pumps	35	62	67
145	Replace bearings and shafts	22	40	48
146	Lubricate equipment	48	76	74
	MAINTAIN VEHICLES IN GOOD WORKING ORDER			
147	Service vehicles	28%	57%	44%
148	Repair and/or maintain vehicles	25	45	33
149	Operate trucks in a safe & careful manner	38	65	81
150	Clean and wash down workshop area	38	64	74
151	Maintain shift log and record meter and gauge readings	35	53	48

Question Number	WASTEWATER TREATMENT GENERAL SKILLS	Operator Grade Level I	II	III
152	Identify potential safety hazards on equipment	58	57	74
153	Identify various hand and power tools	61	59	78
154	Select appropriate hand and power tools for specific jobs	60	65	78
155	Store tools properly	60	65	78
156	Wear appropriate clothing	61	67	81
157	Provide proper ventilation when needed	64	67	70
158	Apply wood and metal preservatives	41	52	63
159	Clean and oil electric motors	61	62	48
160	Replace fuses	51	55	64
161	Replace electrical switches	42	37	37
162	Wire simple electrical circuit	41	40	45
163	Install electric motors	39	41	49
164	Reset circuit breakers	64	60	70
165	Repair broken electrical wires	38	38	45
166	Replace lighting fixtures	35	46	48
167	Replace electric motor belts and pulleys	41	53	59
168	Cut weeds and grass around buildings	67	70	73
169	Replace water pipes	35	45	49
170	Repair faucets	32	51	67
171	Replace valves in water system	29	49	52
	GENERAL LABORATORY KNOWLEDGE AND SKILLS			
172	Use safety precautions & procedures necessary to work in a laboratory	54%	60%	78%
173	Use first aid techniques necessary to care for minor laboratory accidents	48	47	63
174	Properly handle hazardous materials	55	53	74

Question Number	WASTEWATER TREATMENT GENERAL LABORATORY KNOWLEDGE AND SKILLS	Operator Grade Level I	II	III
175	Add acid to water	32	42	59
176	Observe fire regulations regarding storage of explosive or inflammable materials	48	52	74
177	Use different types of sampling devices	51	57	70
178	Practice personal hygiene when handling wastewater	65	64	81
179	Wear protective clothing during the collection of a sample	48	57	67
180	Collect a representative sample	65	69	89
181	Prepare a diluted sample solution	51	57	67
182	Select an appropriate sampling location	71	60	85
183	Select representative sampling times	68	56	89
184	Use monitoring wells	18	21	38
185	Know effects of effluent on ecology	51	52	78
186	Take and preserve a composite sample	71	66	89
187	Observe state and local laws regarding sampling requirements	67	61	89
188	Observe OSHA	51	57	81
189	Preserve samples	61	57	78
190	Prepare samples before testing	58	64	81
191	Operate the microscope	19	23	26
192	Record test results	74	67	85
193	Clean laboratory equipment	65	65	81
194	Sterilize laboratory equipment	25	35	40
195	Operate a sterilizer	19	23	19
	COMMON SKILLS IN PERFORMING LABORATORY TESTS			
196	Use various apparatus necessary to perform the tests	64%	58%	85%
197	Use reagents where necessary	47	58	70

Question Number	WASTEWATER TREATMENT COMMON SKILLS IN PERFORMING LABORATORY TESTS	Operator Grade Level I	Operator Grade Level II	Operator Grade Level III
198	Prepare standard (normal) solution	39	39	30
199	Follow standard procedures for each test	57	57	74
200	Observe precautions in conducting each test	52	57	81
201	Make the necessary calculations	62	59	89
202	Use a lab notebook	44	50	56
203	Record results of each test	65	59	85
204	Order chemicals and equipment for tests	55	48	64
205	Dispose of wast chemicals	45	51	60
206	Use proper labeling in the laboratory	48	55	67
207	Store chemicals	54	52	78
	TEST FOR ORGANIC CHARACTERISTICS OF:			
208	Biochemical oxygen demand	41%	51%	70%
209	Total organic carbon	9	11	4
210	Chemical oxygen demand	12	18	8
211	Total nitrogen	16	17	29
212	Total phosphorous	6	15	8
	TEST FOR CHLORINE			
213	Use Hach or other kit type methods	16%	28%	37%
214	Use an amperometric titration method	9	17	7
215	Use titrimetric methods	16	12	11
	OPERATE A:			
216	pH meter	44%	57%	74%

Question Number	WASTEWATER TREATMENT	Operator Grade Level		
		I	II	III
	OPERATE A:			
217	Analytical balance	29	42	59
218	Spectrophotometer	12	20	29
219	Specific ion meter and electrodes	6	7	0
220	Microscope	9	15	22
221	DO meter	16	26	26
	TEST FOR THE PHYSICAL QUALITY BY:			
222	Turbidity	9%	21%	23%
223	Color	28	24	19
	TEST THE BIOLOGICAL QUALITY OF WATER BY:			
224	Total coliform by membrane filter method	3%	6%	0%
225	Total coliform by fermentation tube method	0	6	0
226	Fecal coliform	3	14	15
227	Fecal streptococci	3	2	0
	TEST FOR THE CHEMICAL QUANTITY OF:			
228	Arsenic	0%	0%	4%
229	Cadmium	0	4	4
230	Chlorides	3	6	4
231	Chromium	3	8	12
232	Copper	0	4	4
233	Cyanide	3	8	12
234	Iron	6	4	4
235	Lead	0	4	0

Question Number	WASTEWATER TREATMENT TEST FOR THE CHEMICAL QUANTITY OF:	Operator Grade Level I	II	III
236	Manganese	6	4	0
237	Mercury	3	4	0
238	Nitrate	3	7	11
239	Organic pesticides	0	0	0
240	Selenium	0	0	0
241	Silver	0	2	0
242	Sodium	0	4	0
243	Sulfate	0	4	4
244	Zinc	0	4	8
245	Phenols	0	0	4
246	Filterable Residue (Total suspended solids)	23	35	59
247	Total Residue (Total solids)	12	26	41
248	Ammonia	48	35	67
249	pH value	48	42	78
250	Phosphate	3	4	0
251	Alkalinity	12	17	15
252	Aluminum	0	2	0
253	Potassium	3	4	0
254	Residual chlorine	12	14	22
255	Chlorine demand	9	6	4
256	Volatile solids	18	20	37
257	Volatile acids	15	11	22
258	Total acidity	18	11	8

WATER TREATMENT

One hundred and forty three (143) potential tasks were included in the water treatment section of this survey. Fifty six responding grade II operators indicated that only 78 of the 143 tasks identified were actually being performed at least once a year. Many of the 65 tasks not performed were related to specific lab tasks. These tests are relative to a wide variety of conditions generally not found in common areas around Iowa.

The original water treatment program at Kirkwood (1974 to 1978) taught 132 of the 143 tasks identified. That is a 92.4% efficiency level. The original program also contained 94% of the 78 tasks identified by grade II operators as being performed by 25% or more operators in the field.

The revised program will include the 73 tasks identified in the survey as being performed by 25% or more of the grade II water treatment plant operators which were not included in the original program and will be in the new program. The revised program will address 98.7% of the 78 tasks. It will also include 12 additional tasks which were identified as being important because of recent technological changes and state and federal level laws. One task was deleted at this time because the necessary equipment is not available at the training center. There are a total of 89 tasks which will be taught in the water treatment programs. The program increased its task proficiency over the former program by 4.7%.

Question Number	WATER TREATMENT	Operator Grade Level		
	WELLS	I	II	III
1	Perform water level test	55%	75%	66%
2	Maintain water level records	46	64	60
3	Read flow meters	73	84	88
4	Operate electric well pumps	81	84	65
5	Operate auxiliary driven pumps	33	46	54
6	Perform routine high lift pump maintenance (change packing, grease)	42	63	54
7	Perform major pump repair (replace sleeve, bearings etc.)	12	32	41
8	Maintain flow records	73	89	82
9	Operate plant control valves	77	82	76
10	Maintain electrical pump controls	63	61	59
	STORAGE FACILITIES (RESERVOIRS, STANDPIPES, ELEVATED TANKS)			
11	Maintain water level indicators	51%	71%	60%
12	Maintain telemetry equipment	22	42	36
13	Maintain water level control equipment	45	62	36
14	Perform periodic inspection of storage unit	54	62	53
15	Clean storage unit	41	43	41
16	Operate cathodic protection devices	6	15	36
	DIFFERENTIAL PRESSURE METERS (VENTURI & ORIFICE)			
17	Perform routine maintenance	45%	40%	42%
18	Operate rapid sand filters	37	47	71%
19	Maintain rapid sand filters	24	36	54
20	Operate pressure filters	25	27	18

Question Number	WATER TREATMENT	Operator Grade Level		
	DIFFERENTIAL PRESSURE METERS	I	II	III
21	Maintain pressure filters	20	24	18
22	Operate sedimentation basins	18	22	41
23	Maintain sedimentation basins	20	22	36
24	Operate lime-soda ash softening systems	14	18	41
25	Maintain lime-soda ash softening equipment	12	15	35
26	Operate zeolite filters	8	16	12
27	Maintain zeolite filters	4	15	12
28	Operate aerators	43	42	53
29	Maintain aerators	37	38	36
30	Operate taste and odor removal equipment	23	33	24
31	Maintain taste and odor removal equipment	22	31	18
	CHEMICAL EQUIPMENT			
32	Add chemicals to feeders (fluoride, chlorine, carbon black etc.	69%	75%	88%
33	Determine proper dosage	60	71%	88
34	Add dry chemical feeders	17	28	71
35	Adjust feeders for proper dosage	44	53	76
36	Maintain chemicals used record	55	70	88
37	Inventory chemicals	52	69	81
38	Perform periodic maintenance of feed equipment (dry, wet and slakers)	43	55	76
39	Repair chlorinator	38	58	59
40	Repair feed equipment	36	45	82
	MAINTENANCE OF PLANT AND GROUPS			
41	Paint building (interior and equipment)	71%	79%	47%

Question Number	WATER TREATMENT MAINTENANCE OF PLANT AND GROUPS	Operator Grade Level I	II	III
42	Maintain grounds (cutting grass, trimming trees)	65	83	42
	GENERAL LABORATORY/KNOWLEDGE AND SKILLS			
43	Use safety precautions and procedures necessary to work in a laboratory	37%	64%	82%
44	Use first aid techniques necessary to care for minor laboratory accidents	33	59	71
45	Properly handle hazardous materials	46	68	76
46	Add acid to water	37	49	71
47	Observe fire regulations regarding storage of explosive or inflammable materials	44	62	76
48	Use different types of sampling devices	40	58	82
49	Practice personal hygiene when handling wastewater	43	55	65
50	Wear protective clothing during the collection of a sample	25	43	47
51	Collect a representative sample	59	63	82
52	Select an appropriate sampling location	54	64	76
53	Select representative sampling times	50	62	76
54	Use monitoring wells	12	17	30
55	Know effects of effluent on ecology	20	31	59
56	Collect and preserve a composite sample	18	26	53
57	Observe State and local laws regarding sampling requirements	54	68	82
58	Observe OSHA	50	64	82
59	Preserve samples	33	46	60
60	Prepare samples before testing	42	56	76
61	Operate the microscope	12	16	30
62	Record test results	52	71	88
63	Clean laboratory equipment	45	64	86
64	Sterilize laboratory equipment	12	24	42

Question Number	WATER TREATMENT	Operator Grade Level		
	GENERAL LABORATORY/KNOWLEDGE AND SKILLS	I	II	III
65	Operate a sterilizer	10	21	30
66	Use a "jar test" for coagulation control	12	16	36
67	Make algae examinations on raw water	8	11	30
	COMMON SKILLS IN PERFORMING LABORATORY TESTS			
68	Use various apparatus necessary to perform test	51%	64%	76%
69	Use reagents where necessary	49	66	82
70	Follow standard procedures for each test	51	64	82
71	Observe precautions in conducting each test	51	64	82
72	Make the necessary calculations	49	62	71
73	Keep a lab notebook	39	50	47
74	Record results of each test	53	68	82
75	Order chemicals and equipment for tests	48	58	59
76	Dispose of waste chemicals	37	52	59
77	Use proper labeling in the laboratory	39	57	65
78	Store chemicals	52	54	71
	TEST FOR ORGANIC CHARACTERISTICS OF:			
79	Biochemical oxygen demand	12%	13%	6%
80	Total organic carbon	2	2	0
81	Chemical oxygen demand	6	7	0
82	Total nitrogen	2	7	6
83	Total phosphorous	6	6	6

Question Number	WATER TREATMENT	Operator Grade Level		
	TEST FOR CHLORINE	I	II	III
84	Use Hach or other kit type methods	73	71	82%
85	Use an amperometric titration method	6	10	6
86	Use titrimetric methods	4	13	42
	OPERATE A:			
87	pH meter	29%	52%	65%
88	Analytical balance	6	20	18
89	Spectrophotometer	8	14	18
90	Specific Ion meter and electrodes	4	11	6
91	Microscope	6	13	12
92	DO meter	10	10	0
	TEST FOR THE PHYSICAL QUALITY BY:			
93	Taste	39%	45%	59%
94	Odor	35	41	53
95	Temperature	33	46	65
96	Turbidity	25	41	59
97	Color	29	34	53
98	Conductance	0	2	12
	TEST FOR RADIOACTIVITY OF:			
99	Alpha activity	0%	4%	0%
100	Beta activity	0	4	0

Question Number	WATER TREATMENT	Operator Grade Level		
	TEST THE BIOLOGICAL QUALITY OF WATER BY	I	II	III
101	Total coliform by membrane filter method	6	4	6%
102	Total coliform by fermentation tube method	2	0	6
103	Fecal coliform	4	2	0
104	Fecal streptococci	4	2	0
	TEST FOR FLUORIDE			
105	Use Hach or other kit type methods	25%	46%	65%
106	Use a fluoride ion electrode	2	8	6
107	Use EPA or APHA standard methods	12	24	42
	TEST FOR NITRATE			
108	Use Hach or other kit type methods	12%	21%	24%
109	Use a nitrate ion electrode	2	4	0
110	Use brucine colormetric method	4	4	6
111	Use cadmium reduction method	0	0	6
	TEST FOR THE CHEMICAL QUANTITY OF			
112	Alkyl Benzene Sulfonates (ABS)	0%	0%	0%
113	Arsenic	0	2	0
114	Barium	0	2	0
115	Cadmium	0	2	0
116	Chlorides	10	9	6
117	Chromium	2	2	0
118	Copper	2	5	12
119	Cyanide	2	6	0

Question Number	WATER TREATMENT TEST FOR THE CHEMICAL QUANTITY OF:	Operator Grade Level		
		I	II	III
120	Iron	37	33	36
121	Lead	2	6	0
122	Manganese	12	10	18
123	Mercury	0	2	0
124	Nitrate	2	14	18
125	Organic Pesticides	0	2	0
126	Carbon Chloroform Extractables (CCE)	0	0	0
127	Selenium	0	0	0
128	Silver	0	2	0
129	Sodium	0	2	0
130	Sulfate	2	6	6
131	Zinc	0	2	0
132	Phenols	2	2	6
133	Filtrable Residue (Total suspended solids)	4	8	0
134	Total Residue (Total solids)	4	8	12
135	Ammonia	4	8	12
136	pH value	40	47	76
137	Hardness	20	42	76
138	Phosphate	6	13	12
139	Alkalinity	16	23	65
140	Aluminum	0	2	0
141	Potassium	0	4	6
142	Residual Chlorine	41	57	71
143	Chlorine Demand	37	45	65

WATER DISTRIBUTION

There were 85 tasks surveyed in the water distribution section. A total of 66 tasks were actually performed by more than 25% of the 48 state grade level II operators responding in this area.

The original water treatment program at Kirkwood from 1974 to 1978 included 76 of the 85 tasks of this section. That is a 89.4% proficiency level. The original water treatment program also addresses itself to 57 of the 66 tasks listed before making any adjustments (86.4%).

The revised program addresses each of the 66 tasks with 100% proficiency. This is a program improvement of 13.6% program efficiency. The program will include the operator identified 66 tasks, plus 6 tasks necessitated by recent change by Safe Drinking Water Act plus the addition of two areas to be added in the water plant operators workshops held throughout Iowa. This is a total of 74 tasks performed in the water distribution area.

These tasks are:

1 - 66

+ 6 - #49 p. 30, #57 p. 30, #64, #69, #70 p. 31, #73 p. 31

+ 2 - #17, 18 p. 28

Question Number	WATER DISTRIBUTION	Operator Grade Level		
	WELLS	I	II	III
1	Perform water level test	54%	62%	46%
2	Maintain water level records	44	58	46
3	Read flow meters	62	77	54
4	Operate electric well pumps	88	71	54
5	Operate auxiliary driven pumps	32	34	31
6	Perform routine high lift pump maintenance (change packing, grease)	52	52	46
7	Perform major pump repair (replace sleeve, bearings etc.)	21	33	23
8	Maintain flow records	74	73	62
9	Operate plant control valves	76	67	46
10	Maintain electrical pump controls	35	52	39
	WATER MAINS			
11	Perform hydrostatic leakage tests	0%	10%	54%
12	Disinfect new installation	57	54	61
13	Maintain main location records	62	62	77
14	Inspect construction	56	60	62
15	Locate leaks	69	66	62
16	Excavate trench for main repair	33	48	47
17	Use backhoe or other power trenching equipment	33	40	39
18	Install repair clamps or sleeves	55	58	62
19	Prepare or repair lead joints	21	37	38
20	Maintain leak records	24	30	46
21	Thaw frozen main with electric welder	16	17	31
22	Maintain pressure relief valves	27	23	46
23	Maintain vacuum relief valves	9	8	30

Question Number	WATER DISTRIBUTION	Operator Grade Level		
	SYSTEM VALVES	I	II	III
24	Determine type of valves	36	61	77%
25	Determine location of new valves	36	58	85
26	Install valves	45	47	61
27	Exercise valves periodically	47	65	69
28	Repair defective valves	58	52	62
29	Maintain valve location records	47	63	85
30	Maintain valve repair records	24	31	54
31	Install tapping in valves	14	25	38
	HYDRANTS			
32	Determine type of hydrant	29%	46%	46%
33	Determine hydrant location	35	47	54
34	Install new or replacement hydrants	40	56	61
35	Perform periodic inspection	67	69	85
36	Perform periodic flushing	76	73	69
37	Repair defective or damaged hydrants	45	54	62
38	Maintain hydrant location records	40	55	62
39	Maintain hydrant repair records	23	35	61
40	Perform flow and pressure tests	21	50	62
	SERVICE CONNECTIONS			
41	Determine size and location of services	28%	48%	54%
42	Perform tapping operation	33	48	54
43	Install corporation stops	31	50	54
44	Install service lateral	17	23	38

Question Number	WATER DISTRIBUTION SERVICE CONNECTIONS	Operator Grade Level		
		I	II	III
45	Install curb stops	31	27	38
46	Inspect installation of service connection	45	48	55
47	Locate leaks in service	55	60	61
48	Maintain service location records	36	29	39
49	Maintain service repair records	28	22	31
50	Thaw frozen services	21	23	38
	STORAGE FACILITIES (RESERVOIRS, STANDPIPES, ELEVATED TANKS)			
51	Maintain water level indicators	56%	48%	53%
52	Maintain telemetry equipment	14	29	31
53	Maintain water level control equipment	52	50	53
54	Perform periodic inspection of storage unit	51	54	62
55	Clean storage unit	33	23	46
56	Operate cathodic protection devices	5	8	16
57	Maintain cathodic protection devices	2	8	16
	MEASUREMENT POSITIVE DISPLACEMENT METERS			
58	Install customer water meters	48%	59%	61%
59	Read customer water meters	52	56	61
60	Repair utility owned water meters	31	39	39
61	Repair utility owned water meters	42	39	39
62	Maintain meter records	26	40	39

Question Number	WATER DISTRIBUTION DIFFERENTIAL PRESSURE METERS (VENTURI & ORIFICE)	Operator Grade Level I	II	III
63	Perform routine maintenance	13	8	15%
	WATER TREATMENT			
64	Maintain lime-soda ash softening equipment	4%	10%	15%
65	Operate zeolite filters	4	12	8
66	Maintain zeolite filters	2	10	8
67	Operate aerators	31	27	39
68	Maintain aerators	30	25	39
69	Operate taste and odor removal equipment	4	15	15
70	Maintain taste and odor removal equipment	4	14	16
	CHEMICAL TREATMENT			
71	Add chemicals to feeders (fluoride, chlorine, carbon black etc.)	51%	50%	46%
72	Determine proper dosage	38	52	46
73	Add dry chemical feeders	10	19	31
74	Adjust feeders for proper dosage	24	37	39
75	Maintain chemicals used record	34	52	54
76	Perform periodic maintenance of feed equipment (dry, wet & slakers)	26	34	38
77	Perform repairs of feed equipment	21	31	31
	MAINTENANCE			
78	Paint building (interior & equipment)	67	60	39%
79	Maintain grounds (cutting grass, trimming trees)	67	55	39

Question Number	WATER DISTRIBUTION LABORATORY	Operator Grade Level		
		I	II	III
80	Collect a representative sample	79	61	46
81	Select an appropriate sampling location	71	59	53
82	Select representative sampling times	69	54	46
83	Test for chlorine using Hach or other kit-type methods	60	57	54
84	Test for chlorine using amperometric titration method	2	6	0
85	Test for chlorine using titrimetric methods	4	2	0

SUMMARY

The survey tested 651 total tasks related to six treatment plant operations. Plant operators from all over the state identified 439 tasks where 25% or more Grade II operators performed.

The survey provided the following information:

1. The existing Kirkwood Water/Wastewater program provided training for 88.8% of the 449 tasks significant to plant operation.
2. Appropriate revision be made to establish a total competency based program flexible enough to provide part-time and full-time programs.
3. The revised water/wastewater program is more efficient and effective than the former program. The revised program addresses 98% of the 439 tasks.
4. Very few distinctions could be made concerning the tasks done by different grade level operators.
5. Few distinctions could be made to differentiate between the tasks performed by operators and administration.
6. The survey did identify specific job tasks competencies necessary for each of the six areas surveyed.
7. Grade II operators tended to perform a greater number of the total tasks more often than either of Grade I or Grade III operators.
8. A greater number of Grade II operators exist than Grade I or Grade III operators in water and wastewater plants.

RELATIONSHIP OF CURRICULUM CHANGES TO SURVEY FINDINGS

Tasks Identified in the survey

Areas of Survey	Potential Tasks Listed	Significant Tasks Identified by Operator	Tasks Taught in Revised Program
Plant Management	73	60	54
Human Relations	33	31	31
Wastewater Collection	62	40	37
Wastewater Treatment	258	164	162
Water Treatment	143	78	73
Water Distribution	85	66	66
Total Tasks	651	439	423

TASKS EXCLUDED FROM THE PROGRAM

Areas of Survey	Excluded From Department	Taught Outside	Excluded from Program*	
			Less than 25%	More than 25%
Management	18	0	12	6
Human Relations	13	12	1	0
Wastewater Collection	22	3	18	1
Wastewater Treatment	73	1	70	2
Water Treatment	51	1	49	1
Water Distribution	15	2	12	1
Total Tasks	192	19	162*	11*

*Indicates those tasks which Grade II operators performed

1976 STATE SURVEY OF WATER/WASTEWATER TREATMENT PLANT OPERATORS

Skills Learned Outside the Department

	Task	Survey Section	Dept. Title
Pg. 4	#5 Use telephone	Human Relations	Communication Skills
	#6 Write letters	" "	" "
	#7 Socialize with fellow employees	" "	" "
	#9 Encourage employees to ask questions	" "	" "
	#10 Promote morale of subordinates	" "	" "
	#12 Express problems or grievances	" "	" "
	#13 Ask questions when necessary	" "	" "
	#14 Establish oral communication	" "	" "
	#15 Promote morale of fellow workers	" "	" "
	#19 Communicate with subordinates	" "	" "
	#20 Communicate with fellow workers	" "	" "
Pg. 5	#32 Work w/persons of different religous denominations	" "	" "
	#33 Explain plant operations	" "	" "
	#27 Like my job (self-esteem, awareness)	" "	?
Pg. 6	#8 Use backhoe or other power trenching equipment	WW Collection	(Special workshop TBO)
Pg. 7	#47 Operate excavation equip. (backhoe, dozer etc.)	" "	" "

	Task	Survey Section	Dept. Title
	#49 Maintain sewer construction equip.	WW. Collection	(Special workshop TBO)
Pg. 8	#58 Use survey equipment (transit tape, chain)	" "	(Health Science)
Pg. 17	#188 Observe OSHA	WW Treatment	" "
Pg. 23	#58 Observe OSHA	" "	" "
Pg. 28	#16 Excavate trench for main repair	Water Dist.	Special Workshop
	#17 Use backhoe or other power trenching equip.	" "	" "

COMMUNICATION SKILLS

Definition of Tasks

Maintain public relations with employees, government, industry and community.

Promote plant image.

Exercise self-control in trying situations.

Communicate with superiors.

Belong to a community service club.

Take pride in work performed.

Maintain openmindedness to new methods.

Conduct plant tours.

BASIC ENVIRONMENTAL SCIENCE

Addresses cycles of nature with emphasis on ecological and microbiological theory as it relates to water and wastewater treatment. An introduction to the organic chemistry and physics of wastewater treatment is included.

Definition of Tasks

Know biological processes which occur in the wastewater treatment process.

BASIC LAB SKILLS

Emphasizes the use and care of basic laboratory glassware and equipment including laboratory safety procedures. Discussion of basic chemical equations, solutions, and acid-base titrations is included.

Definition of Tasks

Keep a lab notebook.

Record results of each test.

Order chemicals and equipment for tests

Dispose of waste chemicals.

Use proper labeling in the laboratory

Store chemicals.

GENERAL LABORATORY/KNOWLEDGE AND SKILLS

Use safety precautions and procedures necessary to work in a laboratory.

Use first aid techniques necessary to care for minor laboratory accidents.

Properly handle hazardous materials.

Add acid to water.

Observe fire regulations regarding storage of explosive or inflammable materials.

Operate the microscope.

Record test results.

Clean laboratory equipment.

Sterilize laboratory equipment.

Operate a sterilizer.

Observe precautions in conducting each test.

Prepare standard (normal) solution.

pH meter.

Analytical balance.

Spectrophotometer

INTRODUCTION TO WATER AND WASTEWATER TREATMENT

Introduces the basic concepts and principles of water and wastewater treatment. Emphasis is placed on terminology and unit process identification.

Definition of Tasks

GENERAL WASTEWATER TREATMENT--KNOWLEDGE & SKILLS

Know biological processes which occur in the wastewater treatment process.

Know basic operating principles of the treatment equipment.

Dress appropriately for the job.

Identify various hand and power tools.

Select appropriate hand and power tools for specific jobs.

Store tools properly.

Wear appropriate clothing.

Provide proper ventilation when needed.

Apply wood and metal preservatives.

Practice personal hygiene when handling wastewater.

Wear protective clothing during the collection of a sample.

MAINTENANCE OF PLANT AND GROUPS

Paint building (interior and equipment).

Maintain grounds (cutting grass, trimming trees).

MAINTENANCE

Paint building (interior & equipment).

Maintain grounds (cutting grass, trimming trees).

WATER RESOURCES

Surveys the hydrologic cycle and its relationship to water as a resource for human consumption, agricultural and industrial usage. Includes discussion of water pollution and its effects on man and the environment.

Definition of Tasks

Prepare press releases.

Know effects of effluent on ecology.

LAGOONS

Discusses principles and concepts of operation and maintenance of waste stabilization lagoons. Series flow, parallel flow, fill and draw operation, loading, detention time, and drawdown are covered.

Definition of Tasks

Operate a single cell pond system.

Operate a two or more cell pond system.

Perform routine maintenance on the ponds.

Remove, disassemble and repair inlet and outlet structures on the pond system.

Interpret lab data for pond system.

WELLS

Provides instruction on ground water movement, general design, construction, and maintenance of water wells, and calculation of well performance.

Definition of Tasks

Perform water level test.

Maintain water level records.

Read flow meters.

Maintain flow records.

PUMPS

Includes instruction in basic operating principles, maintenance, and repair procedures of pumps typically found in water and wastewater treatment facilities.

Definition of Tasks

Determine repair parts needed.

GENERAL OPERATION AND MAINTENANCE

Inspect pumps for obstructions.

Perform routine maintenance for pumps.

Remove, disassemble and repair pumps.

Replace burned out motors.

Replace gaskets and seals.

Inspect pumps for proper operation.

Know basic operating principles of pumps.

Repack pumps.

Replace bearings and shafts.

Lubricate equipment.

Clean and oil electric motore.

Install electric motors.

BASIC ELECTRICITY

Addresses the basic concepts of electricity including definitions, voltage and current measurements, and energy consumption. Circuit and equipment protection devices and personal safety are discussed.

Definition of Tasks

Determine power consumption.

Reset circuit breakers.

Repair broken electrical wires.

Replace lighting fixtures.

Replace fuses.

Replace electrical switches.

Wire simple electrical circuit.

Maintain electrical pump controls.

WATER & WASTEWATER PLANT ADMINISTRATION

Offers instruction and practice in planning and conducting an organized system of plant record keeping and report writing. An introduction to personnel procedures, public relations, and municipal management responsibilities in water and wastewater processing is included.

Definition of Tasks

Determine services needed.

Identify sources for service.

Compare quality and costs of services.

Order services.

Keep service department records.

Determine consumable supplies needed.

Identify sources of consumable supplies.

Compare quality and costs of consumable supplies.

Order consumable supplies needed.

Identify sources of repair parts.

Compare quality and costs of repair parts.

Order repair parts.

Prepare requisitions or purchase orders.

Approve requisitions or purchase orders.

Keep records of purchase orders.

Check invoices for receipt of material ordered.

Approve invoices for payment.

Take inventories.

Select standardization of equipment and material.

Keep system operation records.

Keep system maintenance records.

Keep equipment maintenance records.

Prepare daily and monthly reports.

Prepare annual reports.

Review architectural and engineering plans.

Promote plant expansion.

Identify potential safety hazards on equipment.

MANAGEMENT

Prepare long-range plans.

Plan, implement and evaluate goal achievement.

Identify staffing needs.

Recruit employees.

Orient new employees.

Evaluate employee performance.

Train employees.

Keep records of employees.

Personally oversee employee activity.

Personally oversee plant activity.

Encourage and promote professional growth (short courses, visits to other plants).

Establish work priorities.

Assign responsibility to others.

Prepare time sheets.

Inform employees of their working schedule.

Determine fuel and power costs.

Determine maintenance and operation costs.

Determine equipment costs.

File information, reports and records.

HUMAN RELATIONS

Inform public of upcoming problems (main flushing, service interruptions).

Respond to "outside" complaints.

Deal with employee's grievances.

MAINTAIN VEHICLES IN GOOD WORKING ORDER

Service vehicles.

Repair and/or maintain vehicles.

Operate trucks in a safe and careful manner.

Clean and wash down workshop area.

Maintain shift log and record meter and gauge readings.

HUMAN RELATIONS

Maintain honesty and integrity.

Demonstrate initiative.

Volunteer for work which is not described as a part of my job.

Work with little or no supervision.

Like my job.

Use time efficiently.

Work with women.

Work with minority races.

Enforce sewer use ordinance.

OPERATIONS REPORTS

Presents instruction in the proper method for completing State and Federal discharge permit reports.

Definition of Tasks

Maintain operating records for State and regulatory agencies.

Fill out discharge permits.

WASTEWATER COLLECTION

Covers the collection of wastewaters gy gravity and pumping. Discussion of design, installation, maintenance, and repair of wastewater collection systems is included. Manhole safety is emphasized.

Definition of Tasks

Operate high velocity water jet.

Operate power rodder.

Operate bucket cleaning machine.

Open stopped main line.

Open stopped lateral line.

Repair of main line.

Repair of lateral line.

Open stopped storm sewer line.

Repair storm sewer line.

Remove cover from a manhole.

Check manhole for oxygen deficient atmosphere.

Check manhole for toxic gases.

Check manhole for explosive gases.

Inspect manhole for obstructions.

Inspect manhole for inflow.

Inspect manhole for inflltration.

Clean manhole.

Repair manhole.

Raise manhole rings.

Raise manhole walls.

Install flow meter in manhole.

Operate flow meter.

Monitor and record readings from flow meter.

Ventilate manholes for safe entry.

Use breathing apparatus for safe manhole entry.

Inspect sewer lines for obstruction and deterioration.

Identify causes of obstruction or corrosion of sewer.

Add chemicals for odor control.

WASTEWATER TREATMENT I

Focuses on the operation and maintenance of wastewater treatment processes. Pretreatment, sedimentation, trickling filters, and basic solids handling are covered. Hands-on operation of the pilot wastewater treatment plant is included.

Definition of Tasks

Identify needed operational changes.

Take meter readings.

Record use of consummable supplies.

Operate backflow check valves.

Inspect check valves for obstructions.

Perform routine maintenance on check valves.

Remove, disassemble and repair check valves.

Operate primary settlng basin.

Perform routine maintenance on primary settling basin (collector drives, collectors weirs etc.)

TRICKLING FILTER

Operate trickling filter.

Monitor treatment performance of trickling filter.

Perform routine maintenance on trickling filter.

Operate trickling filter, dosing chambers.

Operate secondary settling basin.

Perform routine maintenance on secondary settling basin.

Recirculate process sewage flow.

Recirculate secondary underflow.

CHLORINATION

Observe safety practices when handling chlorine.

Change chlorine cylinders.

Handle chlorine cylinders.

Weigh and record chlorine cylinders.

Inspect gauges on evaporator.

Know operating principles of chlorine cylinders.

Operate chlorinator.

GENERAL OPERATION AND MAINTENANCE

Operate screening removal equipment

Maintain screening removal equipment.

Operate grit collection and removal equipment.

Maintain grit collection & removal equipment.

Operate flow control equipment.

Operate flow measurement equipment.

Calculate organic loads.

Calculate overflow rates and hydraulic loads.

Monitor control panels, gauges, instruments for flow control and measurement.

Inspect screening removal process for obstructions.

Inspect grit removal process for obstructions.

Inspect flow control and measurement process for obstructions and interferences.

Operate valves and gates.

Maintain valves and gates.

Remove, disassemble and repair valves and gates.

Remove, disassemble and repair screening process equipment.

Remove, disassemble and repair grit process equipment.

Operate centrifugal pumps

Operate positive displacement pumps.

Remove, disassemble, repair, reassemble and install treatment equipment.

Observe safety practices in removing and installing treatment equipment.

Know the effects environmental conditions have on the treatment process.

Use meters & gauges in treating wastewater.

Read meters and gauges.

Know the functions of meters and gauges in treating waste.

Operate monitoring control panels in treating wastewater.

Complete appropriate forms when checking conditions of treatment process.

Check treatment equipment for proper functioning.

Operate valves in treating and discharging wastewater.

Know relationship of head and gate opening and flow of waste.

Record operating output of pumps.

Record water levels.

Monitor water levels in channels.

Inspect outfall for erosion and other damages.

Grease and lubricate process equipment.

Clean up around the pumping station.

Operate pumps.

GENERAL WASTEWATER TREATMENT--KNOWLEDGE AND SKILLS

Select and use appropriate tools for removing, disassembling, repairing, reassembling and installing process equipment.

SLUDGE PROCESSING

Operate drying beds or drying lagoons.

Clean drying beds.

SOLIDS DISPOSAL

Dispose of dry sludge at a landfill.

Operate a land spreading system for sludge.

Perform routine maintenance on sludge spreading equipment (liquid or dry sludge.)

Perform maintenance operations in a shop.

WATER TREATMENT

Offers instruction in water treatment methods, equipment, maintenance, and plant control. Hands-on pilot plant operation of coagulation, softening, sand filtration, and chlorination units is included.

Definition of Tasks

DIFFERENTIAL PRESSURE METERS (VENTURI & ORIFICE)

Perform routine maintenance.

Operate rapid sand filters.

Maintain rapid sand filters.

Operate pressure filters.

Maintain pressure filters.

Operate aerators.

Maintain aerators.

Operate taste and odor removal equipment.

Maintain taste and odor removal equipment.

Operate plant control valves.

CHEMICAL EQUIPMENT

Add chemicals to feeders (fluoride, chlorine, carbon black etc.)

Determine proper dosage.

Add dry chemical feeders.

Adjust feeders for proper dosage.

Maintain chemicals used record.

Inventory chemicals.

Perform periodic maintenance of feed equipment (dry, wet and slakers).

Repair chlorinator.

Repair feed equipment.

Compare water losses with water production.

WASTEWATER ANALYSIS I

Provides instruction in the basic parameters of wastewater analysis with emphasis on approved BOD, solids, and ammonia analysis procedures as required by State and Federal discharge permits.

Definition of Tasks

Sample in sewer system.

Inspect sewer construction jobs.

Locate buried sewers and other pipes for excavation.

Routine maintenance of sewer cleaning equipment.

Operate sewer system lift stations.

Use chemical sewer cleaning compounds.

Update sewer system maps.

Use sewer system maps and sewer profiles.

Maintain special devices (grit chambers, grease traps etc.)

Obtain samples from primary clarifier.

Obtain samples of primary sludge.

Monitor dissolved oxygen levels in plant.

Use different types of sampling devices.

Collect a representative sample.

Prepare a diluted sample solution.

Select an appropriate sampling location.

Select representative sampling times.

Take and preserve a composite sample.

Observe state and local laws regarding sampling requirements.

Preserve samples.

Prepare samples before testing.

Make the necessary calculations.

Biochemical oxygen demand.

Follow standard procedures for each test.

Residual chlorine.

Specific ion meter and electrodes.

DO meter.

TEST FOR THE PHYSICAL QUALITY BY:

Turbidity

TEST THE BIOLOGICAL QUALITY OF WATER BY:

Fecal coliform.

Filterable residue (total suspended solids).

Total residue (total solids).

Ammonia

pH value

Use an amperometric titration method.

Use titrimetric methods.

Use Hach or other kit type methods.

Use various apparatus necessary to perform the tests.

Use reagents where necessary.

WASTEWATER ANALYSIS II

Covers advanced wastewater analysis procedures such as oils and grease, COD, seeded BOD, fecal coliform, and phosphorus determinations. Discussion and demonstration of other advanced procedures are included.

Definition of Tasks

Monitor industrial discharges.

Alkalinity

Volatile solids

Volatile acids

Chemical oxygen demand

Test for chlorine.

WASTEWATER TREATMENT II (continued)

Use digestor gas for heating, power generation or other uses in the treatment plant.

Remove, disassemble and repair digestion process equipment.

Interpret lab data on the digestor(s).

Operate an aerobic digestion system.

Perform routine maintenance on the aerobic digestion system.

WASTEWATER TREATMENT II

Emphasizes the operation and maintenance of the activated sludge process units, solids treatment process units, and rotating biological filters. Hands-on pilot plant operation is included.

Definition of Tasks

Maintain flow control equipment.

Maintain control panels, gauges, instruments for flow control and measurements.

Maintain flow measurement equipment.

Calibrate flow measure equipment.

Remove, disassemble, and repair flow control equipment.

Remove, disassemble and repair flow measurement equipment.

CHLORINATION

Know effect of chlorine on wastewater.

Know effect of chlorine on air, metal, cloth and humans.

Inspect pumps for proper operation.

Inspect chlorinators for proper operation (pressure and leaks).

Interpret lab data on chlorine dosage.

Record the amount of chlorine used daily.

Unload full chlorine cylinders and store on specified site.

Store and load empty chlorine cylinders.

Remove, disassemble, repair, reassemble and install treatment equipment.

Observe safety practices in removing and installing treatment equipment.

DIGESTORS

Maintain gas sludge meters.

Operate anaerobic digestors.

Perform routine maintenance on digestors.

WATER ANALYSIS

Covers basic principles of approved chemical and microbiological analyses of potable water. Laboratory techniques include hardness, iron, alkalinity, fluoride, chlorine, turbidity, and coliform determinations. Discussion and demonstration of advanced analytical procedures are included.

Definition of Tasks

TEST FOR THE CHEMICAL QUANTITY OF:

Iron

Nitrate

pH value

Hardness

Alkalinity

Residual chlorine

Chlorine demand

TEST FOR THE PHYSICAL QUALITY BY:

Taste

Odor

Temperature

Turbidity

Color

TEST FOR FLUORIDE

Use Hach or other kit type methods.

Use a fluoride ion electrode.

Use EPA or APHA standard methods

COMMON SKILLS IN PERFORMING LABORATORY TESTS

Use various apparatus necessary to perform test.

Use reagents where necessary

Follow standard procedures for each test.

Collect a representative sample.

Select an appropriate sampling location.

Select representative sampling times.

Collect and preserve a composite sample.

Observe State and local laws regarding sampling requirements.

Preserve samples.

Prepare samples before testing.

TEST FOR NITRATE

Use Hach or other kit type methods.

Use a nitrate ion electrode.

TEST FOR CHLORINE

Use Hach or other kit type methods.

TEST THE BIOLOGICAL QUALITY OF WATER BY:

Total coliform by membrane filter method.

Total coliform by fermentation tube method.

Fecal coliform.

Specific ion meter and electrodes.

Use different types of sampling devices.

Use a "jar test" for coagulation control.

Observe precautions in conducting each test.

Make the necessary calculations.

LABORATORY

Collect a representative sample.

Select an appropriate sampling location.

WATER ANALYSIS (continued)

Select representative sampling times.

Test for chlorine using Hach or other kit-type methods.

WATER DISTRIBUTION

Focuses on design principles, installation, repair, and operation of water distribution and storage components, such as hydrants, meters, and cross-connection prevention devices. Includes discussion of basic hydraulics and flow measurement devices.

Definition of Tasks

Determine type of hydrant.

Determine hydrant location.

Install new or replacement hydrants.

Perform periodic inspection.

Perform periodic flushing.

Repair defective or damaged hydrants.

Maintain hydrant location records.

Maintain hydrant repair records.

Perform flow and pressure tests.

SERVICE CONNECTIONS

Determine size and location of services.

Perform tapping operation.

Install corporation stops.

Install curb stops.

Inspect installation of service connection.

Locate leaks in service.

Maintain service location records.

Maintain service repair records.

STORAGE FACILITIES (RESERVOIRS, STANDPIPES, ELEVATED TANKS)

Maintain water level indicators.

Maintain water level control equipment.

Perform periodic inspection of storage unit.

WATER DISTRIBUTION (continued)

Clean storage unit.

Maintain cathodic protection devices.

MEASUREMENT POSITIVE DISPLACEMENT METERS

Install customer water meters.

Read customer water meters.

Repair utility owned water meters.

WELLS

Perform water level test.

Maintain water level records.

Read flow meters.

Operate electric well pumps.

Operate auxiliary driven pumps.

Perform routine high lift pump maintenance (change packing, grease).

Perform major pump repair (replace sleeve, bearings etc.)

Maintain flow records.

Operate plant control valves.

Maintain electrical pump controls

WATER MAINS

Disinfect new installation.

Maintain main location records.

Inspect construction.

Locate leaks

Install repair clamps or sleeves.

Prepare or repair lead joints.

Maintain leak records.

SYSTEM VALUES

Determine type of valves.

Determine location of new valves.

Install valves.

Exercise valves periodically.

Repair defective valves.

Maintain valve location records.

Maintain valve repair records.

Install tapping in valves.

STORAGE FACILITIES (RESERVOIRS, STANDPIPES, ELEVATED TANKS)

Operate cathodic protection devices.

Operate electric well pumps.

Operate auxiliary driven pumps.

Perform routine high lift pump maintenance (change packing, grease).

Perform major pump repair (replace sleeve, bearings etc.)

II. CURRICULUM

A. Design

Two types of data were needed to establish a competency based water/wastewater curriculum: (A) Identification of the tasks taught in each of the courses of the existing program and (B) Identification of the tasks (competencies) which Grade II operators felt pertinent to their jobs. This data provided the basis for: (1) Identifying job/task and human relation competencies for successful entry into and advancement within the Water and Wastewater Technology field - III. A. 1.*; (2) Converting the existing curriculum of the Water and Wastewater Technology Program to a competency based format - III. A. 2.; (3) Developing a competency based testing program within the water and wastewater program which would permit students to "test out" of any number of instructional units within the program - III. A. 4.; (4) Developing and piloting a multi-level variable entry exit components within the water and wastewater program - III. A. 7.; (5) Providing training to any student regardless of sex, race, religion, creed or color - III. A. 9.

B. Development

Curriculum revision was based on those tasks which:
(1) Were not presently addressed in the existing curriculum; and
(2) Were performed by more than 25% of the Grade II operators.

Each instructor of the water/wastewater program at Kirkwood identified those tasks listed in the survey for which he/she taught. Those competencies which were found to be performed on a regular basis by operators, but not found in the existing program, were identified.

All instructors of the department were responsible for the development and revision of the existing program to allow for variable entry and exit, and competency modifications in a series of joint departmental meetings. Over 98% of the tasks identified in the survey as being applicable competencies were included in the modified program. Specific course modifications were made through a team effort by individual instructors and curriculum developers. The modules were then presented to students in the form of instruction for student input.

Survey forms and information pertinent to the existing program and competencies changes can be found in the report section labeled "Survey Findings", "Existing Program" and "Revised Program". Also, two examples of the modified program modules developed by Kirkwood instructors can be found in the section entitled "Samples of Competency-Based Curriculum Taught at Kirkwood".

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* Refers to the "Objectives and Intended Outcomes" section of the grant proposal.

C. Evaluation

Curriculum changes made were evaluated through the use of several evaluation techniques: (1) College "SPOT" course evaluation forms; (2) A Likert-Osgood schematic differential scales and multiple choice questions. Copies of these forms can be found in this report in the section entitled "Evaluation Forms Used in the Revision of Competency-Based Modules".

EXISTING PROGRAM

EXISTING PROGRAM FOR WATER AND WASTEWATER TECHNOLOGY PROGRAM

First Quarter

Credits	Course Title	Hrs.	Credits	Course Title	Hrs.	Credits	Course Title	Hrs
15	Water Resources & Water Quality Control	240	5	Beginning Algebra	60	4	Principles of Microbiology	60
Second Quarter								
16	Water Treatment & Distribution	264	4	Intro. to Physics	60	3	Communications Skills I	36
Third Quarter								
21	Wastewater Treatment	300	4	Principles of Chemistry	60			
Fourth Quarter								
2	Water & Wastewater Plant Administration	24	6	Research Projects	80	3	Principles of Management	48
13	Supervised Field Study	320						

Revised Curriculum

COURSE OFFERINGS

Fall			Winter			Spring		
Credits	Course Title	Contact Hrs./wk.	Credits	Course Title	Contact Hrs./wk.	Credits	Course Title	Contact Hrs./wk.
2	Intro. W & WW	2	3	Env. Science II	4	4	WW Treatment II	8
2	Basic Lab Skills	3	3	WW Treatment I	6	2	WW Analysis II	4
3	Env. Science I	4	2	WW Analysis I	4	3	Comm. Skills	3
3	H_2O Treatment	6	2	Basic Elec.	2	2	Lagoons	2
2	H_2O Analysis	4	1	Reports	1	2	Plant Adm.	2
1	Pumps	2	2	H_2O Res.	2	2	WW Collection	3
5	Math	5	2	Wells	2	2	Spec. Proj.	4
2	H_2O Dist.	4	2	H_2O Dist.	4	5	Math	5
1	Reports	1	2	Intro. W & WW	2			
2	Spec. Proj.	4	2	Basic Lab Skills	3			

FALL ENTRY

Fall

Credits	Course Title	Contact Hrs./wk.
2	Intro. W & WW	2
2	Basic Lab Skills	4
3	*Env. Science I	4
3	*H_2O Treatment	6
2	*H_2O Analysis	4
1	*Pumps	2
5	Math	5
	Total	27

Winter

Credits	Course Title	Contact Hrs./wk.
3	*Env. Science II	4
3	*WW Treatment I	6
2	*WW Analysis I	4
2	*Basic Elec.	2
1	Reports	1
2	*H_2O Res.	2
2	*Wells	2
2	H_2O Dist.	4
	Total	25

Spring

Credits	Course Title	Contact Hrs./wk
4	*WW Treatment II	8
2	*WW Analysis II	4
3	Comm. Skills	3
2	*Lagoons	2
2	*Plant Adm.	2
2	*WW Collection	3
2	Spec. Proj.	4
	Total	26

Summer

Internship 40 or electives totalling 12 credits

* Winter entry students in this class also.

FALL ENTRY - PART TIME

Fall			Winter			Spring			Summer	
2	Intro. to W & WW	2	3	*Env. Science II	4	4	**WW Treatment II	8	Math	5
2	*Basic Lab Skills	4	2	*WW Analysis I	4	2	**WW Analysis II	4	Elective	4
3	*Env. Science I	4	3	*WW Treatment I	6	2	*Lagoons	2		
1	**Pumps	2								
	Total	12			14			14		

3	**H_2O Treatment	6	2	**Basic Elec.	2	2	*WW Collection	3	Electives	8
2	*H_2O Analysis	4	2	**H_2O Res.	2	2	Spec. Proj.	4		
2	Plant Adm.	2	2	Wells	2	1	Reports	1		
			2	H_2O Dist.	4	3	Comm. Skills	3		
	Total	12			10			11		

Plus internship 40

WINTER ENTRY

Winter

Credits	Course Title	Contact Hrs./wk.
2	Intro. W & WW	2
2	Basic Lab Skills	4
3	Env. Science II	4
3	WW Treatment I	6
2	WW Analysis I	4
2	Basic Elec.	2
2	H_2O Res.	2
2	Wells	2
	Total	26

Spring

Credits	Course Title	Contact Hrs./wk.
4	WW Treatment II	8
2	WW Analysis II	4
3	Comm. Skills	3
2	Lagoons	2
2	Plant Adm.	2
2	WW Collection	3
5	Math	5
	Total	27

Fall

Credits	Course Title	Contact Hrs/wk.
3	Env. Science I	4
3	H_2O Treatment	6
2	H_2O Analysis	4
1	Pumps	2
2	H_2O Dist.	4
1	Reports	1
2	Spec. Proj.	4
	Total	25

Summer

Internship 40 or electives totalling 12 credits

SPRING ENTRY - Part Time

Spring			Summer			Fall			Winter		
2	Lagoons	2		Electives 6	6	2	Basic Lab Skills	4	3	Env. Science II	4
2	WW Collection	3				3	Env. Science I	4	2	WW Analysis I	4
1	Reports	1				2	W. Analysis	4	3	WW Treatment I	6
2	Intro. W & WW	2									
5	Math	5									
	Total	13					Total	12		Total	14
4	WW Treatment II	8		Electives 6	6	1	Pumps	2	2	Basic Elec.	2
2	WW Analysis II	4	2	Spec. Proj.	4	3	Water Treat.	6	2	Water Res.	2
						2	Plant Adm.	2	2	Wells	2
3	Comm. Skills	3							2	Water Dist.	4
	Total	15					Total	10		Total	10

Samples of Competency-Based
Curriculum Taught at Kirkwood

BASIC LAB SKILLS

ABSTRACT

Basic Laboratory Skills is a course designed to provide water and wastewater laboratory personnel with the skills basic to working in either a chemistry laboratory or microbiological laboratory.

This course includes hands-on practice, examining and using the equipment, chemicals and procedures discussed.

Module No:	Topic: SUMMARY

Instructor Notes:	Instructor Outline:
Basic Laboratory Skills	1. Discuss, demonstrate and have student participate in laboratory practice and sessions concerning basic laboratory skills.

General Skills

Safety
Notebooks & Bench Sheets
Labeling
Sampling
ID of lab equipment & glassware
Chemical names and formulas
Matter (solids)
Solutions
Dilution techniques
Incubators
Balances

Chemistry Skills

Analytical analysis
Volumetric glassware
Standardization of reagents
Colorimetric analysis
Standard curves
Lab supplies & chemicals
Standard References

Microbiology Skills

Laboratory cleanliness
Equipment packaging
Media & reagent preparation
Sterilization
Microscopes
Aseptic technique
Microbiological sample collection
Microbiological dilution techniques

Instructor must provide all necessary equipment for laboratory practice sessions. Necessary information or what equipment needed in handout materials.

Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
General Skills

Approx. Time:
1 hour

Topic:
Safety

Objectives:

Upon completion of this module, the participant should be able to:

1. Locate the following in the laboratory and indicate its proper use: Safety shower, fire extinguisher, fire blanket, eye wash, first aid kit and instruction sheet, fume hood.
2. Select the proper pieces of equipment given an emergency situation.
3. State when safety glasses, lab aprons and lab gloves will be used.
4. Given a list of common lab chemicals state their safety hazard and proper storage method.

Instructional Aids:

Handout: Laboratory Safety
Fire extinguishers A, BC, ABC, OCD
Fire blanket
Eye wash
First aid kit

Instructional Approach:

Lecture
Demonstration
Discussion

References:

Manual for Sanitary Chemistry and Sanitary Microbiology, Linn-Benton Community College, Carnegie & Wooley, 1975.

Standard Methods, 14th Edition

Wastewater Laboratory Procedures & Chemistry, from Operation of Wastewater Treatment Plants by Kerri.

Class Assignments:

Read handout

Module No:	Topic: Safety
Instructor Notes:	**Instructor Outline:**
	1. Identify, describe and demonstrate the use of
	a. Safety showers
Distinguish between A, B, & C class extinguishers. Show Soda Water CO_2, Dry chemical	b. Fire extinguisher
	c. Fire blanket
	d. Eye wash
Do not try to teach a first aid course in this module.	e. First aid kit with instruction sheet
Demonstrate top draw and bottom draw on a fume hood.	f. Fume hood
	2. a. Describe emergency situations and indicat proper actions.
Stress that no two emergency situations are the same.	b. Have participants indicate how the situation could be prevented and what actions must be taken after the incident.
Handout Laboratory Safety	3. Discuss personal protection equipment and the use of it.
[redacted]	4. Discuss handout chemical hazards. Participant must be able to state the safety hazards and proper storage methods of Group A chemicals on handout.

LABORATORY SAFETY
Carnegie & Wooley
Manual for Sanitary Chemistry & Sanitary Microbiology
Linn Benton Community College
Albany, Oregon

Introduction

For the inexperienced and careless operator, the treatment plant laboratory can be extremely hazardous. The laboratory is not necessarily a dangerous place, however. Intelligent precautions and an understanding of proper techniques make the laboratory less dangerous than most other industries.

A number of hazardous materials and conditions do exist. Be aware of these dangers. Prevent accidents.

Personal Protection

1. Wear Safety Goggles or Eyeglasses

   Eyes must be protected from splashing chemicals and flying broken glass by wearing goggles at all times.

2. Wear Lab Coat or Apron and Protective Shoes

   Protect clothing and body from corrosive chemicals. Tennis shoes or sandals are not acceptable.

3. Know Location of Safety Equipment

   A first-aid cabinet, a fire extinguisher, a fire blanket and an eye-wash fountain should be available. Know exactly where they are located and how to use them.

4. Toxic Fumes

   Any test involving a dangerous or unpleasant volatile material should be performed in a hood or well-ventilated part of the laboratory.

5. Measuring Chemicals

Never handle chemicals with the hands. Always use a spatula. Do not drip liquid chemicals. Pour stock solutions into a small beaker, then into the graduate. Pipette from the beaker, not the stock solution bottle.

6. High Temperature

Use protective gloves or long handled tongs when using autoclave, hot plate, furnace or oven.

7. Broken Glassware

Discard or repair cracked or broken glassware immediately.

8. Electrical

Check all electrical equipment to see that it is properly wired and grounded.

9. Wash up

Always wash your hands after handling chemical containers and test apparatus.

10. Eating

Never use glassware for serving food. Always wash before eating or smoking. It is not good to eat in the laboratory at all.

11. Labels

Always label containers with name of material, concentration, date, and your initials. This will prevent accidents with acids, etc. in unlabeled beakers and also prevent use of wrong reagents in lab tests.

Corrosive Chemicals

1. Acids (Sulfuric, Hydrochloric, Nitric, Glacial Acetic
    - a. Concentrated acids are extremely corrosive to everything, including skin. Use glass and polyethylene containers.
    - b. In case of spills, immediately add large quantities of water to the area and neutralize with sodium bicarbonate. Then clean up the area.
    - c. Contact with skin burns very quickly. Wash immediately with large quantities of water and neutralize with sodium bicarbonate.
    - d. Dilute concentrated acid by adding the acid to the water, never the reverse.
    - e. Always pipette with a rubber bulb.
    - f. In general, do not mix strong acids with strong bases. If it is necessary to mix these solutions, do so very slowly, with mixing and cooling in cold tap water or ice water.
2. Bases (Sodium Hydroxide, Potassium Hydroxide, Ammonium Hydroxide)
    - a. Concentrated bases are also extremely corrosive to skin and clothing. Use glass (with rubber stopper) and polyethylene containers. Do not use glass stoppered bottles.
    - b. In case of spill, wash with large quantities of water and neutralize with saturated boric acid solution.
    - c. Always pipette with rubber bulb.
3. Others
    - a. Chlorine gas - Secure covers to prevent escape of vapor.
    - b. Ferric chloride - Extremely corrosive to metals. Avoid contact with skin.

Toxic Chemicals

1. Avoid Ingestion or Inhalation
    - a. Solids - Cyanides, chromium, cadmium.
    - b. Liquids - Carbon tetrachloride, ammonium hydroxide, nitric acid, bromine, chlorine water, chloroform, carbon disulfide. Use in hood.
    - c. Gases - Hydrogen sulfide, chlorine, ammonia, hydrochloric acid. Use in hood.
2. Most Chemicals Have Warnings and Antidotes on Their Labels. Read Them Before you Use the Chemical.

Explosive or Flammable Materials

1. Acetylene, hydrogen, carbon disulfide, benzene, ethyl ether, petroleum ether, acetone. Store the materials according to fire regulations.
2. Use in hood. Do not use near open flame of exposed heating element. Do not smoke near the chemicals. Use extreme caution during distillation. Do not distill to dryness.

Infectious Materials

Although it is highly unlikely that an operator would contract diseases by working in a treatment plant, the possibility does exist.

1. Sewage contains bacteria and viruses which can cause diseases. Some diseases are contracted through breaks in the skin. Keep wounds covered and if necessary, wear protective gloves.
2. Some are contracted through the digestive tract. The best protection is to wash thoroughly after performing tests to avoid transferring bacteria to mouth while eating.
3. Immunization is provided for many of the diseases. Operators are encouraged to take full advantage of this type of protection.

Module No:	**Module Title:** Basic Laboratory Skills
	Submodule Title: General Skills
Approx. Time: 30 Min.	**Topic:** Notebooks and Bench Sheets

Objectives:

Upon completion of this module, the participant should be able to:

1. Describe information to be included in a general lab notebook.
2. Describe the utility of a lab bench sheet.

Instructional Aids:

Handouts
1. Lab notebooks
2. Bench sheets

Instructional Approach:

Lecture

References:

None

Class Assignments:

Read handouts

Module No:	Topic: Notebooks and Bench Sheets

Instructor Notes:	Instructor Outline:
Handout Lab Notebooks	Discuss lab notebooks Why they are kept What must be in one
Handouts Bench sheets	Discuss the use of bench sheets and their relationship to lab notebooks.
	Discuss bench sheets examples.

INSTRUCTIONS FOR KEEPING LABORATORY NOTEBOOKS

1. Entries should be recorded in ink or ball-point pen by the person doing the work, on the same day the work was done. Such person should date the page at the beginning of each day's entry and should initial the page after each day's entry. Entries should be made on only one side of each page. The blank side facing each page may be used for calculations not constituting a material part of the information recorded.
2. Each new project should, as a first entry, include a clear, concise statement of what is to be done and what is hoped to be achieved. All entries should be made in such detail that anyone not directly associated with the work will be able to read and understand the scope and object of the work described.
3. Each page should be filled in completely either with written matter or diagonal lines before starting on the next page. No blanks should be left, for example, for later insertion of analyses.
4. No attempt should ever be made to correct or obliterate any entry. Necessary corrections or deletions should be made by drawing a single line through the portion to be deleted, being sure to leave the original matter legible. As required, substitute words may be written above the deleted matter. All such changes should be initialed and dated as of the date of correction. If possible, an explanation of the change should be made either in the margin or immediately following the correction if that portion of the page has not already been filled.

5. Any sketches or drawings which are not originally made on the notebook pages may be inserted but care should be taken that each page is appropriately identified by title and date. Reference should be made in the text of the notebook entry to such insertions and the date when such pages became available. This will refute any charge that such inserted pages were prepared at a date later than indicated.
6. Each person who has the duty of recording experiments should have his own notebook and should not permit others to make entries in it. In the case of shift work this rule may be relaxed if the records are otherwise adequately corroborated.
7. There is no objection to having separate notebooks for separate projects but care should be taken to insure that entries are made in chronologica order and that there is sufficient identification of each entry to maintain continuity.

SOLIDS DETERMINATION

Percent Total Solids (T.S.) and Percent Volatile Solids (V.S.)

Source			
Dish No.			
Weight of Dish + Sample			
Weight of Dish			
Weight of Wet Sample			
Weight of Dish + Sample After Drying			
Weight of Dish			
Weight of Dry Sample			
% Total Solids			
Average T.S.			
Weight of Dish + Sample After Ignition			
Weight of Dish			
Weight of Residue			
% Fixed Solids			
Average			

Formulae:

1. $\frac{\text{Wt. of Dry Sample}}{\text{Wt. of Wet Sample}} \times 100 = \%$ Total Solids (T.S.)
2. 100 - % Total Solids = % of Moisture
3. $\frac{\text{Wt. of Residue}}{\text{Wt. of Dry Sample}} \times 100 = \%$ Fixed Solids (F.S.)
4. 100 - % Fixed Solids = % Volatile Solids (V.S.)

This method is usually used in sludge solids analysis.

Module No:	**Module Title:** Basic Laboratory Skills
	Submodule Title: General Skills
Approx. Time: 30 Min.	**Topic:** Labeling

Objectives:

Upon completion of this module, the participant should be able to:

1. Describe the necessity of proper labeling of chemical stock bottles, sample bottles, flasks etc.
2. State the information required on a chemical stock bottle.
3. State the information required on a sample bottle.

Instructional Aids:

Handout: "Labels"

Instructional Approach:

Lecture

References:

Self-monitoring Procedures, Basic Laboratory Skills, USEPA, Engel, Highby, Wagner.

Class Assignments:

Read handouts

Module No:	Topic: Labeling

Instructor Notes:	Instructor Outline:
	1. a. Discuss labeling of chemical stock bottles, sample bottles and flasks.
	b. Discuss dating of chemicals and reagents.
	c. Discuss sample labeling
Handout: Labels	2. List the data required on chemical stock bottle.
	3. List the data required on a sample bottle.

LABELS

Labeling

When a chemical or a piece of equipment is used for a specific analysis, it should have some type of identification. When you prepare a chemical from a stock container (purchased from a supply house), you must identify that chemical properly. The stock container will have all the necessary information on its label. A general format for labeling reagent bottles is as follows.

Chemical Name
Chemical Formula
Concentration

Date Initials

In preparing a chemical reagent a specific procedure would be as follows:

> Prepare a sulfuric acid solution 10% by volume by pouring 10 ml of concentrated sulfuric acid (H_2SO_4), into 90 ml of distilled water. Cool the solution to room temperature and transfer to a storage bottle.

The label should be:

Sulfuric Acid
H_2SO_4
10% by Volume

12/19/74 WTE

All necessary information has been included on the label to properly identify it. It takes a little more time but it is well worth it in the long run.

Several labeling tools are available, and each has its place in the laboratory. Most beakers and flasks will have a hexagon space of ground glas which can be used to identify it.

A lead pencil should be used for this type of marking.

Grease pencils are primarily used for test tubes. It should be noted that the grease pencil marking will readily rub off. When porcelain is labeled, a special technique should be used, since the item will be repeatedly heated and cooled. An etching device such as a Vibra-Groover, should first be used to put either a number or letter on the item. Next the etching should be filled in by rubbing it with a stick dipped in 1% Ferric Chloride ($FeCl_3$) solution (can either be prepared or commercially purchased). The porcelain crucible or other item is then placed in a muffle furnace (Approximately 600° C.) and fired for 10 minutes. After cooling the porcelai is ready for use. Whatever labeling techniques you use, be consistent, and remember that the label is intended not only for convenience but also for safety.

Chemical Name	Potassium Dicromate
Symbol	$K_2CR_2O_2$
Concentration	0.250 N
Date	July 5, 1977
Prepared by	By John Dow

Sample Site	Chlorine Contact Tank Eff.
Time & Date	11:30 A.M. - July 4, 1977
Sample Type	Grab Sample
Type of Preservation	No Preservation
Sampler	By John Dow

Module No:

Module Title:

Submodule Title:

Approx. Time:

1 hour

Topic:

Sampling

Objectives:

1. Explain why sampling and preservation is just as important as the accuracy and precision of the analysis.
2. Differentiate between grab and composite sampling.
3. List three general methods of sample preservation.

Instructional Aids:

Handout: "Sampling"
Handout: Sample Preservation

Instructional Approach:

Lecture

References:

1. Kerri, Wastewater Laboratory Procedures
2. Standard Methods, 14th Edition
3. Methods for Chemical Analysis of Water and Wastewater, USEPA, Technology Transfer

Class Assignments:

Read handouts

Module No:	**Topic:** Sampling

Instructor Notes:	**Instructor Outline:**
Handout "Sampling"	1. a. Discuss sampling in general
	b. List the objectives of sampling
	c. Indicate that the analysis and results are only as go at the sample.
	2. a. Differentiate between grab and composite samples.
	b. List types of composite samples.
Handout "Sample Preservation"	3. a. Discuss methods of preservation 1. Retard biological action 2. Retard chemical change 3. Reduce volatility

SAMPLING
Carnegie & Wooley
Manual for Sanitary Chemistry & Sanitary Microbiology
Linn Benton Community College
Albany, Oregon

The most neglected technique in laboratory control tests is in the collection and handling of samples. Even though a test is performed carefully and accurately, the result may be completely wrong and meaningless, unless a good representative sample is taken.

Cardinal Rules

The cardinal rules for sampling spell CAP:

1. CLEANLINESS - of all containers, including caps, and measuring devices that the sample comes in contact with.
2. ACCURACY - of records. The sample label should note the type of sample, source of sample, source, location of sampling point, the date and hour sampled, the temperature of the sample, and recent weather conditions.
3. PRESERVATION. Sewage samples contain living organisms which continue to grow unless the life processes are slowed by lowered temperatures or halted by addition of chemicals. Chemical degredation can also occur if samples are not properly preserved.

Principles of Sampling

1. The sample should be taken where the sewage is well mixed.
2. Large particles which may be in the sewage should be broken into smaller pieces or excluded.
3. No deposits, growths or floating materials that have accumulated at the sampling point should be included.

4. Samples should be tested as soon as possible.

Types of Samples

DEFINITION: A sample is a part of anything that is presented as evidence of the quality of the whole.

1. GRAB SAMPLES. Grab samples are taken because they are necessary or because there is a lack of time to catch composite samples. For some tests grab samples must be used. Tests such as residual chlorine, dissolved oxygen, and pH are determined from grab samples as a portion of sewage which cannot be mixed. For some tests grab samples can be used because the quality of the component to be sampled remains uniform for a period of a day or longer. An example is a digestor sample. A grab sample is simply one taken at a specific time with no regard to flow rate.
2. COMPOSITE SAMPLES. Composite samples are representative of the character of the sewage over a period of time. BOD, settleable solids and suspended solids tests are usually run on composite samples. The effects of intermittent changes in strength and flow are eliminated. The portion collected should be obtained with sufficient frequency to obtain average results. The rate of sewage flow must be measured when each portion is taken and the volume of the portion adjusted to the flow at the particular time of sample. Samples may be composited either by mechanical samplers or by hand. A composite sample is a series of grab samples poured together to make one sample.

Use the following formula to determine the volume of sample to be taken at each sampling interval to obtain a weighted composite sample.

$$\frac{\text{Total sample volume in ml}}{\text{No. of sampling time}} \times \frac{\text{Flow rate at sampling}}{\text{Average flow rate}} = \text{ml sample at sampling time}$$

Sample Preservation

Both grab and composite samples should be chilled to 3^{o} - 4^{o} C immediately. This is particularly true for BOD and all biological tests. Samples for certain tests may require some type of chemical preservative. It is not possible to preserve samples for other tests such as DO and temperature. The following table lists some common tests and preservation methods:

Preservation Methods

Test	Preservative	Maximum Holding Period
Acidity-Alkalinity	Refrigeration at 4°C	24 hours
Biochemical Oxygen Demand	Refrigeration at 4°C	6 hours
Chemical Oxygen Demand	2 ml H_2SO_4 per liter	7 hours
Chloride	None required	----
Color	Refrigeration at 4°C	24 hours
Dissolved Oxygen	Determine on site	No holding
Hardness	None required	----
Nitrogen, Ammonia	40 mg $HgCl_2$ per liter - 4°C	7 days
Nitrogen, Nitrate - Nitrite	40 mg $HgCl_2$ per liter - 4°C	7 days

SAMPLE PRESERVATION

Complete and unequivocal preservation of samples, either domestic sewage, industrial wastes, or natural waters, is a practical impossibility. Regardless of the nature of the sample, complete stability for every constituent can never be achieved. At best, preservation techniques can only retard the chemical and biological changes that inevitably continue after the sample is removed from the parent source. The changes that take place in a sample are either chemical or biological. In the former case, certain changes occur in the chemical structure of the constituents that are a function of physical conditions. Metal cations may precipitate as hydroxides or form complexes with other constituents; cations or anions may may change valence states under certain reducing or oxidizing conditions; other constituents may dissolve or volatilize with the passage of time. Meta cations may also adsorb onto surfaces (glass, plastic, quartz, etc.), such as iron and lead. Biological changes taking place in a sample may change the valence of an element or a radical to a different valence. Soluble constituents may be converted to organically bound materials in cell structures, or cell lysis may result in release of cellular material into solution. The well known nitrogen and phosphorus cycles are examples of biological influence on sample composition.

Methods of preservation are relatively limited and are intended generally to (1) retard biological action, (2) retard hydrolysis of chemical compounds and complexes and (3) reduce volatility of constituents.

Preservation methods are generally limited to pH control, chemical addition, refrigeration, and freezing. Table 1 shows the various preservatives that may be used to retard changes in samples.

Many water and waste samples are unstable. In situations where the interval between sample collection and analysis is long enough to produce changes in either the concentration or the physical state of the constituent to be measured, the preservation practices in Table II are recommended.

TABLE I

Preservative	Action	Applicable to:
$HgCl_2$	Bacterial Inhibitor	Nitrogen forms, Phosphorus forms
Acid (NHO_3)	Metals solvent, prevents precipitation	Metals
Acid (H_2SO_4)	Bacterial Inhibitor	Organic samples (COD, oil & grease organic carbon)
	Salt formation with organic bases	Ammonia, amines
Alkali (NaOH)	Salt formation with volatile compounds	Cyanides, organic acids
Refrigeration	Bacterial Inhibitor	Acidity-alkalinity, organic materials, BOD, color, odor, organic P, organic N, carbon, etc. Biological organism (coliform, etc.)

In summary, refrigeration at temperatures near freezing or below is the best preservation technique available, but it is not applicable to all types of samples.

The recommended choice of preservatives for various constituents is given in Table 2. These choices are based on the accompanying references and on information supplied by various Regional Analytical Quality Control Coordinators.

TABLE 2

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF SAMPLES ACCORDING TO MEASUREMENT (1)

Measurement	Vol. Req. (ml)	Container (2)	Preservative	Holding Time (6)
Acidity	100	P, G	Cool, 4° C.	24 Hrs.
Alkalinity	100	P, G	Cool, 4° C.	24 Hrs.
BOD	1000	P, G	Cool, 4° C.	6 Hrs.
COD	50	P, G	H_2SO_4 to pH 2	7 Days
Dissolved Oxygen Probe	300	G only	Det. on site	No Holding
Winkler	300	G only	Fix on site	No Holding
Nitrogen				
Ammonia	400	P, G	Cool, 4° C. H_2SO_4 to pH 2	24 Hrs. (4)
Kjeldahl	500	P, G	Cool, 4° H_2SO_4 to pH 2	24 Hrs. (4)
Nitrite	50	P, G	Cool, 4° C.	24 Hrs. (4)
Oil & Grease	1000	G only	Cool, 4° C. H_2SO_4 to pH 2	24 Hrs.
pH	25	P, G	Cool, 4° C. Det. on site	6 Hrs. (3)
Residue				

TABLE 2 Cont.

Measurement	Vol. Req. (ml)	Container (2)	Preservative	Holding Time (6)
Filterable	100	P, G	Cool, 4° C.	7 Days
Non-Filterable	100	P, G	Cool, 4° C.	7 Days
Total	100	P, G	Cool, 4° C.	7 Days
Volatile	100	P, G	Cool, 4° C.	7 Days
Settleable Matter	1000	P, G	None Req.	24 Hrs.
Specific Conductance	100	P, G	Cool, 4° C.	24 Hrs.
Temperature	1000	P, G	Det. on site	No Holding
Turbidity	100	P, G	Cool, 4° C.	7 Days

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 23, p. 72 - 91 (1973).
2. Plastic or glass
3. If samples cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.
4. Mercuric chloride may be used as an alternate preservative at a concentration of 40 mg/l, especially if a longer holding time is required. However, the use of mercuric chloride is discouraged whenever possible.

5. If the sample is stabilized by cooling, it should be warmed to 25^{0} C. for reading, or temperature correction made and results reported at 25^{0} C.
6. It has been shown that samples properly preserved may be held for extended periods beyond the recommended holding time.

Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
General Skills

Approx. Time:
2 hours

Topic:
General Lab Equipment and Glassware

Objectives:

Upon completion of this module, the participant should be able to:

1. Identify and operate the following lab equipment: Vacuum pump, lab burner fume hood, lab oven, dessicator, hot plate, stirrer.
2. Identify the following lab glassware: Buret, pipet (volumetric), pipet (mohr), graduated cylinder, Erlenmeyer flask, vacuum flask, volumetric flask, separating funnel, buchner funnel, gooch crucible, watch glass, beaker, Walter crucible holder, buret clamp.
3. Demonstrate proper methods of glassware cleaning and indicate when special cleaning reagents are needed.

Instructional Aids:

Lab equipment per handout
Handouts
1. Laboratory Equipment Description and Use
2. Glassware cleaning

Instructional Approach:

Lecture
Demonstration

References:

Manual for Sanitary Chemistry and Sanitary Microbiology, Carnegie & Wooley.

Class Assignments:

Read handouts

Module No:	Topic: General Lab Equipment and Glassware

Instructor Notes:	Instructor Outline:
	1. Demonstrate the use of: a. Vacuum pump b. Lab burners c. Fume hoods d. Lab ovens e. Dessicators f. Hot plates g. Magnetic stirrers
Proper use of equipment will be covered in following topics. Handout Laboratory equipment description and use.	2. Identify and demonstrate the proper handling and storage of: Burets Pipets Volumetric Mohr Graduated cylinders Erlenmeyer flasks Vacuum flasks Volumetric flasks Separatory funnel Buchner funnel Gooch crucible Watch glass Beaker Walter crucible holder Buret clamp
Handout Glassware cleaning	3. Discuss handout on glassware cleaning Note safety precautions for use of strong acid and strong base cleaning solutions.

LABORATORY EQUIPMENT
DESCRIPTION AND USE

The well equipped treatment plant lab should have the necessary equipment and glassware to perform all necessary tests, some of which will be run simultaneously. In addition, the lab must have the necessary supporting equipment to make up solutions and perform other routine lab tasks. The following items should be considered minimum for an efficient and smoothly operating treatment plant laboratory:

(Mention of any piece of equipment by brand name does not necessarily mean endorsement of that brand by Linn-Benton Community College or the Environmental Protection Agency, but is used for illustrative purposes only.)

1. BALANCES

a. BEAM BALANCE

This balance should have a capacity of 500 g. and a precision of 0.02 g. This balance is used for quick measurements, such as weighing chemicals for the preparation of most solutions. Detailed instructions for the operation of the balance accompany the instrument. Read them thoroughly before attempting to make measurements. In general, treat the instrument gently and keep it clean.

b. ANALYTICAL BALANCE

This balance should have a capacity of 160 g. and a precision of 0.1 mg. This balance is used primarily for solids determinations and for weighing dry chemicals in preparation of standard solutions. Detailed instructions for operation also accompany this instrument. Strict adherence to the directions is necessary to avoid damage. This instrument is extremely sensitive and cannot be jarred or treated roughly. Keep it clean, inside and out.

2. pH EQUIPMENT

a. pH METER

The pH meter should have a range of 0 to 14 pH, and deliver ± 0.1 pH accuracy. This instrument is used to adjust pH of solutions, titrations, and other procedures requiring some degree of accuracy. Detailed instructions for the operation of the pH meter are included in another module.

b. pH TEST PAPER

pH test paper is a convenient tool for getting a rough check of the pH very quickly. It can be obtained in nearly any range. For general use, a range of 1 to 11 pH and an accuracy of 0.5 pH is adequate.

The test paper is treated with an indicator which will change color when moistened. Distinct color changes occur over the entire range of pH. To determine the pH of a solution with pH test paper, obtain a drop solution with a clean Pasteur pipette or stirring rod and apply it to a piece of the test paper. The paper will change color immediately. Determine the pH by comparing the color chart on the dispenser.

3. INCUBATORS

a. BOD INCUBATOR

BOD's are incubated at 20° C. and normally a relatively large number of bottles are used. Therefore, a large cabinet type incubator that will hold several hundred BOD bottles with a sensitivity of ± 0.5° C. is required.

b. BENCH MODEL INCUBATOR

Most bacterial tests are run at 35° C. Therefore, an additional incubator is needed. The incubator should be large enough to accommodate the maximum number of plates which would ever be handled at the same time. Sensitivity should be at least ± 0.2° C.

4. WATERBATH

a. CONTROLLED TEMPERATURE

A water bath at 45° C. is required for fecal coliform membrane filter test. The bath must be large enough to accommodate several plastic bags containing membrane filter dishes. This bath should have a sensitivity of at least ± 0.2° C. and a range from room temperature to 100° C. Several other tests require water baths at different temperatures. Often the same bath can be used, but it must be easily adjusted between tests.

b. STEAM TABLE

The solids tests require a steam table for evaporation of the sample. Often the controlled water bath can double as a steam table if it can be covered properly and still allow the evaporating dish to sit down into the bath. In larger plants, it would be advisable to have a separate steam table, since many of the tests will overlap. The steam table must reach 100° C. and have an automatic overflow water level control.

5. MICROSCOPES

a. COMPOUND MICROSCOPE

A microscope is required for observation of sludge samples and bacteria. The compound microscope should have at least three objective lenses; a low power (10X high dry power (43X), and an oil immersion lens. An electrical light source is recommended. Do not attemp to operate the compound microscope without direct, personal instruction from some one experienced with your particular model.

b. DISSECTING MICROSCOPE

The binocular dissecting microscope is quite helpful in properly identifying coliform colonies in the membrane filter tests. The microscope should have a range of 1X-3X with an electric lamp light source.

6. STIRRING HOT PLATE

The stirring-hot plate is used in the preparation of solutions, as well as in several tests. The heating and stirring units should be able to be operated separately or together. The plate should heat from 150 to 700^0 F. and the stirrer should run from 0 to 1800 rpm.

7. CENTRIFUGE

A small bench top centrifuge is used to clarify some wastewater samples. The instrument should have the capacity to hold 8, 15 ml. or 4, 50 ml. conical centrifuge tubes and run at speeds up to 3200 rpm. A timer is convenient. Caution must be taken in the operations of any centrifuge to be sure the load is balanced. Tubes opposite one another must be the same weight. The weight can be checked on a balance or by leveling the amount of liquid in the two tubes. If only one tube is needed for your samples, make a balance tube up with water. Do not operate the centrifuge with the lid up. Accelerate the centrifuge slowly to avoid undue strain on the motor. Clean up any spills in the instrument immediately.

8. SPECTROPHOTOMETER

The spectrophotometer is required for color intensity determinations on several tests. The instrument shoul have the capacity to work in the ragne of 400-700 mm. Detailed instructions for the operation of the spectrophotometer are included in another section.

9. MUFFLE FURNACE

The muffle furnace is used in the volatile solids tests and must reach a temperature of 600° C. and space enough to handle three or four evaporating dishes is recommended. Use extreme caution when working around the oven. Always wear insulated gloves and use long handled tongs to insert and remove dishes.

10. DRYING OVEN

The drying oven is used to dry crucibles, dishes, filter paper, chemicals, and glassware. It should have a heating capacity of up to 150° C. and control sensitivity of ± 0.5° C. Use caution because of heat. Handle material with tongs or gloves.

11. AUTOCLAVE

The autoclave is used for sterilizing solutions, bacterial growth media, and glassware. It must have the capacity to develop and hold 15 psi at 121° C. for any length of time. Size is not important as long as i is large enough to accommodate the volume of work required. Bench top sterilizers are satisfactory as long as they meet the above requirements. Each autoclave is slightly different. Operating instructio are included with the instrument and should be read prior to operation. Preferably, do not operate without the instruction of someone familiar with the operation of your particular model. Use caution since the autoclave develops high pressures and high temperatures. Always remove hot items with tongs or gloves.

12. WATERSTILL

Distilled water is required in nearly every test performed in the laboratory. High quality distilled water can be obtained from several commercial models. In selecting the still for your lab, determine the quantity of water needed for operation. For most laboratories, a capacity of 2 gal/hour is satisfactory. Directions for operation accompany the still. Of critical importance is not allowing the still to run dry. Some laboratories find it desirable to also process their distilled water through a demineralizer to obtain ultra-pure water. Although this is not required, it is recommended for several tests.

13. BUNSEN BURNER

The Bunsen burner is used as a source of heat for boiling and to sterilize equipment during biological transfers. The burner should be compatible with the type of gas available for fuel. Self-containers gas-cylinder units are available if commercial gas lines are not present.

14. DESICATTOR

The desicattor is used to store items that must not take moisture from the atmosphere. They should be large enough to hold several evaporation dishes.

15. ASPIRATOR

A vacuum pump or aspirator on the sink faucet is needed for several filtration steps. The aspirator can be connected directly to the cold water tap. The vacuum hose should run to a "water-trap" before it is connected to the vacuum flask to prevent water from surging up into the flask where the vacuum is released.

16. BURETS

a. PRECISION BURETS

The buret is essential for several treatment plant tests. It is designed to deliver liquids in a controlled fashion, such that additions can be made dropwise or intermittently and the final volume delivered determined. The straight bore, and Teflon stopcock is recommended for general use. Burets with larger or smaller capacities can be obtained. Fill the buret by adding the liquid with aid of a funnel to the top with the stopcock closed. Fill it well above the 0 ml. mark. Then bleed out the tip so that the orifice through the stopcock and the tip are free of air bubbles. Continue bleeding until the meniscus at the top of the buret reads 0 ml. Dispense the liquid by grasping the stopcock with the left hand, leaving the right hand free to agitate the flask below. After the required volume has been dispensed, read the meniscus. Notice that the values increase from top to bottom. The difference between the final buret reading and the initial buret reading will give the exact volume dispensed. By this method, it is not necessary to refill between each operation. Simply calculate the difference in buret reading as you continue to dispense the liquid. However, be careful not to dispense below the 50 ml. mark.

17. PIPETTES

a. MEASURING PIPETTES

Measuring pipettes are used for a variety of purposes. They can be obtained in capacity from 0.1 ml. to 20 ml. with different subdivisions. Every lab should have a selection of pipettes from 0.1 ml to 20 ml., mostly 1, 5, and 10 ml. volume. Measuring pipettes come in two types; those calibrated clear to the tip and those not calibrated to the tip. The first type is referred to as a "blow-out" pipette, since it is necessary to force the last drop out of the tip in order to deliver the measure volume. The second type is operated on the same principle as a buret. The liquid is drawn up into the pipette and the desired volume delivered by allowing the liquid to drain out, using the meniscus as the indicator of volume delivered.

The liquid can be drawn into the pipette by mouth or by a rubber bulb. In general, it is advisable to use a rubber bulb. Experienced lab technicians may find it more efficient to pipette by mouth, however, never pipette strong acids or bases, toxic solutions, sewage samples, or bacterial cultures by mouth.

b. VOLUMETRIC PIPETTS (TRANSFER PIPETTES)

Volumetric pipettes are designed to give the greatest accuracy in pipettes. They will deliver only one volume and range in capacity from 1 ml. to 50 ml. Each lab should have a supply of 1, 5, 10, 20 and 50 ml. volumetric pipettes. Their operation is identical to the measuring pipettes except that even though they are designed to deliver clear to the tip, they are NOT the blow-out type. They are calibrated to deliver the prescribed volume by simply touching the tip to the side of the container for a few seconds. The small drop remaining in the pipette is not included in the prescribed volume of the pipette.

c. TRANSFER PIPETTES (EYE-DROPPERS)

Transfer pipettes, commonly called eye-droppers, are useful in delivering small unmeasured quantities of liquid such as adding acid to adjust pH in the pH meter. They are operated by using a small rubber bul to take up and dispense the liquid.

18. FLASKS

a. ERLENMEYER FLASK

The Erlenmeyer flask is a general purpose flask used for containing and mixing solutions. They range in capacity from 10 ml. to several liters.

b. FILTER FLASK

The vacuum filter flask is essentially an Erlenmeyer flask with a side-arm attachment to receive a vacuum hose. Filtration is accomplished by placing a filter funnel in the neck of the flask and drawing the liqui through with the aid of the vacuum.

c. VOLUMETRIC FLASK

The volumetric flask is designed to accurately measur large volumes of liquid, primarily in the preparatio of reagents and standard solutions. They range in size from 1 ml. to 2000 ml. The 50, 100, 500, and 1000 ml. sizes are recommended for general lab use. The volumetric flask is calibrated to contain the prescribed volume, not to deliver. The stoppered variety is more convenient for use in solution preparation.

19. GRADUATED CYLINDERS

Graduated cylinders, or graduated, are used to measure large volumes of liquid and are calibrated "to deliver" not "to contain". That means, if the graduate is filled and the contents poured out, it will deliver the prescribed volume. The drops left behind are not included in the prescribed volume. It is considered volumetric but does not have the accuracy of the volumetric flask. Graduates range from 5 ml. to 2000 ml. Sizes of 10, 50, 100, 200, 500, 1000 ml. are recommended for general lab use.

20. BEAKERS

Beakers are the most common non-volumetric piece of glassware and range in size from 1 ml. to 4000 ml. Sizes of 50, 150, 250, 600, 1000, and 2000 ml. are recommended for general lab use. Although they do have graduations, they should not be used to measure accurate volumes.

21. BOTTLES

a. PLASTIC BOTTLE

Polyethylene bottles are convenient to use for chemical storage. Such bottles can be used to collec and transfer sewage samples. Dark colored plastic bottles protect light sensitive chemicals. High temperature polyethylene can be sterilized by autoclaving. Sizes from 1 oz. to several gallons are available in a variety of designs.

b. GLASS STOPPERED BOTTLES

Glass stoppered bottles are ideal for strong acid solutions, and many other reagents. However, strong bases tend to "freeze" the stoppers. Rubber stoppers should be used for strong bases. Glass stoppered bottles range in size from 30 to 2000 ml.

c. MILK DILUTION BOTTLES

Dilution bottles are 125 ml. volume glass bottles with one calibration at 99 ml. They are used for bacterial and sewage dilutions and can be autoclaved.

d. DROPPING BOTTLES

Dropping bottles with hooded glass stopper or small eye droppers attached are recommended for use with stains and indicators.

e. SQUEEZE BOTTLES

Plastic squeeze bottles are used to dispense distilled water during rinsing operations.

f. CARBOYS

Large plastic carboys, from 2-12 gallon capacity, with spigots, are recommended for storage of distilled water, buffered water, and dilution water.

22. EVAPORATING DISHES

Porcelain evaporating dishes are used to dry chemicals and sewage samples. Sizes of 70 and 150 ml. capacity are recommended. Sufficient number to handle several samples each day should be on hand.

23. GOOCH CRUCIBLE

The Gooch crucible is used in solids determination. The 35 ml. size is recommended. The illustration shows the crucible in the rubber-adapter for filtering flask.

24. IMHOFF CONE

The one liter volume with blunt tip for raw sewage and sharp tip for final sewage is used for settleable solids determinations.

25. BUCHNER FUNNELS

Porcelain Buchner funnels are used in solids determinations. The 80 mm. and 115 mm. diameter sizes would be recommended.

26. TONGS

a. CRUCIBLE TONGS

Both the normal 9" and long 20" tongs are recommended.

b. EVAPORATING DISH TONGS

Stainless-steel safety dish tongs are best for handling hot evaporating dishes.

c. BEAKER TONGS

For hot beakers and other similar objects, the Safety Beaker clamp is recommended.

d. FLASK TONGS

In addition, the Safety Flask Clamp is recommended.

27. BACTERIOLOGICAL EQUIPMENT

a. PETRI DISHES

Either glass or disposable plastic petri dishes are acceptable. For the membrane filter procedures, the 60 x 15 mm. size is recommended. The 100 x 20 mm. size is used for total plate count and wherever agar plates are required.

b. MEMBRANE FILTRATION APPARATUS

A stainless steel or glass funnel, with base and filter support screen for 47 mm. diameter membrane filters is recommended. The whole apparatus must be able to withstand autoclaving.

d. WIRE LOOPS

A platinum wire loop with a 3 mm. loop is used for bacteriological transfers. A wooden or aluminum handle is acceptable.

28. FILTER PAPER

a. STANDARD FILTER PAPER

A high grade, medium weight, rapid filtering paper comparable to Whatman No. 1 is required for several tests. It is recommended to have a selection of sizes (7, 11, & 24 cm.) on hand.

b. MEMBRANE FILTERS

Sterile membrane filters with sterile absorbent pads are required for the membrane filter tests. The filters should be 47 mm. in diameter, 0.45 mm. pore size, white with grid.

c. GLASS FIBER FILTERS

Ultra-fine filter, which retains particles in the semi-colloidal range with a thickness of 0.26 mm. and a diameter of 2.4 cm. is required for the suspended solids test. Filters equivalent to Whatman Grade GF/C is acceptable.

29. MISCELLANEOUS ACCESSORIES

a. RUBBER STOPPERS
b. CORK STOPPERS
c. RUBBER TUBING
d. TYGON TUBING
e. VACUUM TUBING
f. RING STANDS
g. RINGS & FUNNEL SUPPORTS
h. CLAY TRIANGLE
i. HOSE CLAMPS
j. ASBESTOS PAD

k. SPATULA

l. FORCEPS

m. PIPETTE FILLER (BULB)

n. CRUCIBLE HOLDER

o. ASBESTOS GLOVES

p. PIPETTE WASHER

GLASSWARE CLEANING METHODS
Carnegie & Wooley
Manual for Sanitary Chemistry & Sanitary Microbiology
Linn Benton Community College
Albany, Oregon

Clean glassware is essential to performing meaningful tests. Normally it is easiest to clean immediately after use, since materials will dry and stick to the glass if left for a period of time. If stored in a closed shelf it will not generally be necessary to wash again before use, however for extremely sensitive tests a distilled water rinse would be advisable before use.

Cleaning Solutions

1. Chromic Acid
   - A. Dissolve approximately 60 g of potassium dichromate in hot water.
   - B. Slowly add enough concentrated sulfuric acid to make one liter. Commercial preparations of this mixture are available from several chemical supply houses.
2. Hot Detergent

   Laboratory detergents are available in several forms. To avoid excess sudsing, use sparingly.

Cleaning Methods

1. Stopcock Grease (Petroleum Base)
   - A. Dissolve grease in acetone.
   - B. Wash with detergent.
   - C. Rinse with tap water four times.
   - D. Rinse with distilled water three times.

2. Stopcock Grease (Silicone Base)
   - A. Soak for one half to two hours in sulfuric acid.
   - B. Rinse with acetone.
   - C. Wash with detergent.
   - D. Rinse with tap water four times.
   - E. Rinse with distilled water three times.
3. Bacteriological Contamination
   - A. Soak in chromic acid mixture.
   - B. Rinse with tap water 6 - 10 times
   - C. Rinse with distilled water three times.
4. Fat and Oil Contamination
   - A. Soak in chromic acid mixture.
   - B. Rinse with tap water four times.
   - C. Rinse with distilled water three times.
5. Organic Material
   - A. Soak in chromic acid mixture.
   - B. Rinse with tap water four times.
   - C. Rinse with distilled water three times.

The rinsing operation must always be carried out thoroughly. Trace amounts of metal ions that remain due to carelessness may seriously affect organism growth and testing procedures. If an automatic dishwasher is used, glassware should still be given a thorough distilled water rinse before drying. Glassware may be dried at 103° C.

The cleaning operation is usually simplified if the pipettes, beakers, graduated cylinders, test tubes and flasks are immediately placed in a detergent solution after use. Delicate (and expensive) spectrophotometer cuvettes must be handled with extreme care and never exposed to the harsher cleaning agents.

In certain tests, such as the phosphate determination, special glassware cleaning techniques must be used. Special instruction will be included in the specific section dealing with that test.

Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
General Skills

Approx. Time:
1 hour

Topic:
Chemical Names and Formulas

Objectives:

Upon completion of this module, the participant should be able to:

1. Identify and choose the correct chemicals necessary for an analysis by name and formula given a set of lab chemicals and a list of chemicals required for an analysis.

Instructional Aids:

Handout: Names of Formulas and Compounds

Instructional Approach:

Lecture
Discussion

References:

Basic Lab Skills, Engel Highby Wagner

Class Assignments:

Read handoug
Worksheets in handout

Module No:	Topic: Chemical Names and Formulas

Instructor Notes:	Instructor Outline:
Handout and Worksheets Names and Formulas of Compounds	1. a. Discuss very basic chemical nomenclature. b. Emphasize matching the exact name and formula with the chemical. c. Give examples of common errors in chemical selection by name or formula.

NAMES OF FORMULAS AND COMPOUNDS

In virtually every chemical analysis, the name and formulas of chemical compounds appear. Compounds are pure substances that are composed of two or more elements. Elements may be referred to as the basic building blocks of all substances. At present there are 105 elements known. These elements are shown in the periodic table.

Each element has a particular symbol. The symbol is an abbreviation for that element. The elements numbered (located above the symbol) 1 through 92 occur naturally (i.e. can be found in earth's crust, water or the atmosphere). Elements numbering 93-105 do not occur naturally but have been synthesized in small quantities in the laboratory. The symbols that are used to represent the elements are also used to represent compounds. For example the compound NaCl represents the combination of sodium (Na) (#11) and chlorine (Cl #17) and its name is sodium chloride.

All the chemical procedures that are included in this course will always refer to a compound with its formula and name together. For example: Prepare a 10% by volume sulfuric acid (H_2SO_4) solution by . . . Weigh out 186.15 grams of sodium thiosulfate ($Na_2S_2O_3$) . . . In several of the chemical formulas, you will note that subscripts are used. The subscript tells us how many atoms of that element are contained in the compound. In water (H_2O) there are two atoms of hydrogen and one atom of oxygen. The subscripts help to differentiate one compound from another. The compound hydrogen peroxide (H_2O_2) although similar to water is obviously not the same since there are 2 atoms of oxygen in the peroxide and only 1 atom in the water.

In choosing the proper chemical for an analysis, it cannot be overemphasized that the name and formula that occur on the label of the chemical must match the name and formula in the procedure that has been given. Several names may appear to be correct because of similarities in spelling such as:

sodium sulfate Na_2SO_4 and

sodium sulfite Na_2SO_3

These are not the same. The sulfate compound has one more oxygen atom than the sulfite. Another minor spelling variation would be potassium nitrate KNO_3 and potassium nitrite KNO_2. What is the difference here?

Another variation and in fact a very important property of compounds is the addition of the word anhydrous to the name. This means without water. The chemical has been prepared (at the factory) without water. If the chemical does have water in it, it will be referred to as hydrate.

Examples

Sodium Thiosulfate Pentahydrate ($Na_2S_2O_3.5H_2O$)

This means that the compound has 5 water molecules associated with it. Note that the prefixes to the word hydrate are mono, di, tri, tetra, penta, hexa, hepta, octa, nona, and deca referring to the numbers 1 through 10 respectively.

Calcium Chloride, Anhydrous ($CaCl_2$)

This means that the compound contains no water.

When choosing a chemical for a particular analysis, the stock chemical bottle must be studied very carefully. It contains a label that gives the name of the compound as well as the formula. It also contains

(CAUTIONS) such as explosive, toxic (poisonous). The hazards presented by these chemicals are not evident from appearance, smell, or everyday knowledge. Hazards must be foreseen and avoided. It is safest to assume that all chemicals, even water if not safely handled, can be hazardous. Read the label completely and follow the warnings that are indicated. The label will also mention any additional storage requirements that might be necessary for a particular reagent such as (Store at 25° C). The purity of the chemical is also indicated. Analytical or Reagent Grade is the highest purity. The amounts of impurities are shown on the label. The word ACS (American Chemical Society) also might be shown. This also means reagent grade. A lower grade of chemical would be laboratory or practical grade. Usually, amounts of impurities would not be listed on this label. A sample label is shown below.

$Na_2S_2O_3.5H_2O$ 5 lbs.
SODIUM THIOSULFATE
(crystals)
Reagent, A. C. S.

CAUTION!!!
Emits Toxic Fumes When Heated
Keep container tightly closed.
Do not take internally.

The exercises on the following pages consist of various check lists and consumable supply lists. For every check list there is a consumable supply list. Complete these as the directions state.

Consumable Supplies I

1. 480 g. manganous sulfate tetrahydrate, $MnSO_4.4H_2O$
2. 500 g. sodium hydroxide, NaOH
3. 125 g. sodium iodide, NaI
4. 10 g. sodium azide, NaN_3
5. 4 plastic weighing boats
6. 1 small size spatula
7. 1 medium size spatula
8. 10 g. soluble starch
9. 10 ml chloroform
10. 186.15 g. sodium thiosulfate pentahydrate, $Na_2S_2O_3.5H_2O$
11. 6 g. potassium biiodate (or potassium biniodate) KH $(IO_3)_2$
12. 3 g. potassium iodide, KI
13. 10 ml concentrated sulfuric acid, H_2SO_4
14. Pen or pencil
15. Paper (to record data)

Check List - I

Chemical Names:

Place number from "consumable" list I by matching name.

_____a. Sodium Nitrate

_____b. Sodium Thiosulfate, Anhydrous

_____c. Sodium Thiosulfate Pentahydrate

_____d. Carbon Tetrachloride

_____e. Manganese Hydroxide

_____f. Manganous Sulfate Tetrahydrate

_____g. Magnesium Sulfate Heptahydrate

_____h. Potassium Bichromate

_____i. Sodium Iodide

_____j. Sodium Fluoride

_____k. Potassium Biiodate

_____l. Sodium Sulfite

_____m. Sodium Thiosulfite

_____n. Dilute Sulfuric Acid

_____o. Sodium Azide

_____p. Sodium Acetate

_____q. Concentrated Sulfuric Acid

_____r. Soluble Starch

Consumable Supplies - II

1. Small wad of cotton
2. 10 g. potassium dehydrogen phosphate, KH_2PO_4
3. 25 g. dipotassium hydrogen phosphate, K_2HPO_4
4. 35 g. disodium hydrogen phosphate heptahydrate, $Na_2HPO_4.7H_2O$
5. 3 g. ammonium chloride, NH_4Cl
6. 25 g. magnesium sulfate heptahydrate, $MgSO_4.7H_2O$
7. 30 g. anhydrous calcium chloride $CaCl_2$
8. 1 g. ferric chloride, $FeCl_3$
9. Manganous sulfate solution*, alkaline iodide azide solution*, starch solution*, standard sodium thiosulfate solution*, and concentrated sulfuric acid*.
10. Pen or pencil
11. Paper (for recording data)
12. Grease pencil

* Listed in the EMP on the Winkler Determination of Dissolved Oxygen azide modification.

Check List - II

Chemical Names:

Place number from "consumable" list by matching name.

_____a. Calcium Chloride Dihydrate

_____b. Sodium Chloride

_____c. Ammonium Chloride

_____d. Ferrous Chloride

_____e. Potassium Dihydrogen Phosphate

_____f. Magnesium Sulfate Heptahydrate

_____g. Ammonium Chlorate

_____h. Calcium Chloride, Anhydrous

_____i. Ferric Chloride

_____j. Dipotassium Hydrogen Phosphate

Consumable Supplies - III

1. 721.8 mg anhydrous potassium nitrate, KNO_3
2. 5.0 g sodium arsenite, $NaAsO_2$
3. 1 g. brucine sulfate, $(C_{23}H_{26}N_2O_4)_2.H_2SO_47H_2O$
4. 0.1 g. sulfanilic acid, $NH_2C_6H_4SO_3H.H_2O$
5. 3 ml concentrated hydrochloric acid, HCl
6. 500 ml concentrated sulfuric acid, H_2SO_4
7. 300 g. sodium chloride, NaCl

Check List - III

Chemical Formulae:

Place the number from the "consumable" list by the matching formula.

_____a. KNO_2

_____b. KCl

_____c. HCl

_____d. KNO_3

_____e. $NaClO_3$

_____f. $(C_{24}H_{28}N_2O_4)_2.H_2SO_4.7H_2O$

_____g. $NaAsO_2$

_____h. $(C_{23}H_{26}N_2O_4)_2.H_2SO_4.7H_2O$

_____i. H_3PO_4

_____j. $HN_2C_6H_4SO_3H.H_2O$

_____k. H_2SO_4

_____l. $NaClO$

_____m. $NaCl$

Module No:	**Module Title:** Basic Laboratory Skills
	Submodule Title: General Skills
Approx. Time: 1 hour	**Topic:** Matter

Objectives:

Upon completion of this module, the participant should be able to:

1. Note and observe volume change of liquids as temperature changes.
2. Note and observe hygroscopic properties of substances.

Instructional Aids:

Dry right, balance, hotplate, beaker, pipet

Instructional Approach:

Demonstration

References:

None

Class Assignments:

None

Module No:	Topic: Matter

Instructor Notes:	Instructor Outline:
Start with cold water. Warm to not more than 50° C.	Demonstrate volume change of water and change in temperature. Demonstrate hydroscopic properties of NaOH and dry-rite using a balance. Weigh some dry-rite from a desiccator. Let set and weigh a second time. Note weight change. Discuss how the above two properties of matter affect accurate measurement.

Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
General Skills

Approx. Time:
1 hour

Topic:
Solutions

Objectives:

Upon completion of this module, the participant should be able to:

1. Calculate the concentration of a solution in mg/l or ppm. given the weight of solute in grams or milligrams and the volume of the solvent in liters.
2. Calculate the percent by weight of a solute given the weight of solute and volume of solution.
3. Recognize the letter N and M following numbers as indicating that the number is describing concentration.

Instructional Aids:

Handout "Solutions"

Instructional Approach:

Lecture

References:

Basic Lab Skills, Engel Highby Wagner

Class Assignments:

Read handout

Module No:	Topic: Solutions

Instructor Notes:	Instructor Outline:
Handout "Solutions"	1. a. Discuss and demonstrate mg/l concentration calculations.
	b. Indicate the relationship between ppm and mg/l
	2. a. Discuss and demonstrate percent by weight calculations.
	3. a. Discuss molarity and normality as forms of chemical concentration measurement.

SOLUTIONS

Wastewater is a complex combination of water, floating and settleable solids, and dissolved solids. It is possible to separate the components of wastewater by physical and mechanical processes such as screening, settling, filtration and evaporation. Since this is the case, the chemist calls wastewater a mixture.

Let us take a sample of raw wastewater and run it through a very fine filter. All the floating and settleable solids will be removed. The filter also removes the turbidity. The filtrate, the liquid which comes through the filter, is a part of the original mixture. It contains water and dissolved solids. This clear liquid could be separated into two more components by distilling off the water. The dissolved solids would be left behind. Thus the filtrate, too, is a mixture. But it is a very special mixture called a solution. The term solution refers to a homogeneous mixture of two or more substances. The molecules of these substances are evenly distributed among one another. Because we cannot see any one component. A solution appears to be one pure substance. The components of a solution will not separate by settling.

The subject of solutions has been introduced by looking at wastewate because it is a mixture known to most of you. However, there are many other solutions which are familiar to you. We will now use some common solutions to continue our study of this important topic.

Chemist classify solutions into three major groups:

1. Gaseous solutions
2. Liquid solutions
3. Solid solutions

We will look at each group separately.

Gaseous solutions are made by mixing one gas in another. Air is a gaseous solution. Air is made of nitrogen, oxygen, argon, carbon dioxide and very small amounts of other gases. The molecules of each gas mix evenly to make a homogeneous mixture called air. The molecules of carbon dioxide are heavier than the molecules of the other gases but they do not settle out. We know that the amount of oxygen in a sample of air can change. There is less oxygen in a sample from the top of a high mountain than there is in a sample taken at sea level. Therefore, we must add to our description of a solution this fact:

The composition of a solution is changeable.

Liquid solutions are made by dissolving a gas, liquid or a solid in a liquid. Tap water is a solution which contains dissolved oxygen. The oxygen molecules are mixed uniformly with the water molecules to make a homogeneous mixture. The oxygen molecules do not settle out if the mixture is allowed to stand undisturbed. "Old Granddad" is an example of a liquid dissolved in another liquid. The alcohol molecules are dissolved uniformly in the water. We know this because every jigger tastes the same. The components of "Old Granddad" do not separate by settling. A sugar-water solution is an example of a solid dissolved in a liquid. The sugar crystals break up into molecules which mix uniformly with the water molecules. This gives a mixture which is homogeneous and there is no settling. We must note here that liquid solutions also have variable compositions. Alcohol-water solutions have different strengths. Sugar-water solutions can be very sweet and not so sweet depending on the amount of sugar added.

Solid solutions are solids in which the molecules of one component are randomly mixed with the molecules of another component. An example of a solid solution is brass, an alloy of zinc and copper. Sterling silver is a solution of copper and silver.

We can now list the characteristics which are common to all solutions:

1. Each component is broken down into molecules or atoms.
2. The molecules or atoms of each component are mixed uniformly.
3. No one component will settle out.
4. Solutions are clear and transparent.
5. The composition of a solution can vary.

To complete our study of the nature of solutions we must note two properties of solutions. These properties apply to all solutions but in varying degrees. The first is the effect of mixing two substances on the total volume of the solution. When one liter of alcohol and one liter of water are mixed, the total volume is less than two liters. When sugar is dissolved in water, the volume of solution is larger than the original volume of water. Thus mixing two substances to make a solution may cause the total volume of solution to be greater or less than the total volume of liquid(s) used.

The second property is a temperature change caused by mixing two different substances. When sulfuric acid, H_2SO_4, or sodium hydroxide NaOH are dissolved in water, the solution initially becomes hot enough to boil or at least form steam. Making solutions of either H_2SO_4 or NaOH should be done slowly and carefully. Use about half the water required and add the acid or base to the water slowly. Allow time for this mixture to cool. Then add the remaining water required slowly. Most acids and bases will cause a temperature increase when mixed with water. The temperature increase results from the reaction of the water with the acid or base. Acids react with water to produce electrically charged hydrogen atoms called hydrogen ions, H^+. Bases react with water producing hydroxide ions, OH^-. These two different reactions both produce heat.

The temperature sometimes decreases when making a solution. When sodium thiosulfate, ($Na_2S_2O_3.5H_2O$), is added to water, the solution is initially cold. When you discover this problem in making a solution you must first dissolve the chemical in about half the required water. Allow time for warming. Then add the remaining required water.

Before we go to a new topic, three new terms must be introduced:

a. Solute

b. Solvent

c. Solubility

The solute is the substance which dissolves. The solvent is the substance which does the dissolving. For a solution involving a solid mixed with a liquid, the solid is considered the solute and the liquid is the solvent. When a liquid is mixed with water, the water is the solvent and the other liquid is the solute.

Examples

1. A salt-water solution	Solute-salt Solvent-water
2. An alcohol-water solution	Solute-alcohol Solvent-water

3. An acid-water solution   Solute-acid
                                   Solvent-water

Solubility is a term which describes the maximum amount of solute which will dissolve in the solvent. Solubility is a property of the solute not the solvent. Table salt, (NaCl), will dissolve in water. The maximum amount is 31.1 g. in every 100 g. of water. If the solvent is alcohol only 0.051 g. of NaCl will dissolve in 100 g. of solvent. When gasoline is the solvent the solubility of sodium chloride is 0.000 g. per 100 g. of solvent. You can see that the solubility of a solute will change when the solvent is changed.

The solubility of a solute in a specific solvent can be affected by temperature changes. In general, the solubility of solids increases with an increase in the temperature of the solvent. The solubility of sodium nitrate, $NaNO_3$, in water is 75 g. per 100 g. of water at 0^{o} C. and 127 g. per 100 g. of water at 60^{o} C.

The solubility of gases decreases with an increase in the temperature of the solvent. The solubility of oxygen in water is about 15 mg in 1 liter of water at 0^{o} C. and about 9 mg. in 1 liter of water at 20^{o} C.

The subject of solubility and the variable nature of the solubility of a solute suggests the problems of specifying the actual amount of solute dissolved in a solvent. The problem is particularly important sinc many chemicals must be dissolved in water before they can be used. To solve the problem chemists have developed a number called the "concentration" of the solution. The concentration number describes the amount of solute in a convenient volume of solution. Suppose 1 liter of solution contains 100 g. of potassium iodide. The concentration is 100 g. per liter of solution or simple 100 g/l of potassium iodide in water. If five liters of solution contains 750 g. of salt then the concentration is 750 g. per 5 liters. Since 5 liters is not a "convenient" volume, we use a proportion to find that the concentration is 15 g/l even though there are actually 5 liters of solution.

The concentration of a solution can be found directly using the formula below:

$$\text{Concentration} = \frac{\text{weight of solute}}{\text{volume of solution}}$$

For example, 600 mg. of NaCl is dissolved in 0.5 l of solution. The concentration is:

$$\text{Concentration} = \frac{\text{600 mg.}}{\text{0.5 l}}$$

Now we simplify the concentration number by dividing the denominator and the numerator by 0.5

$$\text{Concentration} = \frac{\text{1200 mg.}}{\text{1 liter}} \qquad \text{or 1200 mg/liter}$$

The concentration is normally reported in the units mg/l, g/l or ppm. If the weight and volume data are given in units other than milligrams or grams and liters, you can change the given units by the appropriate conversion factors. Then use the formula given. Remember that

1 mg/l = 1 ppm

1000 mg/l = 1 g/l

Two other units of concentration commonly used in chemistry are normality (N) and molarity (M). These are examples of the two units:

0.25N H_2SO_4 -- means a .025 normal solution of sulfuric acid.

2 M NaOH -- means a 2 molar solution of sodium hydroxide.

Module No:

Module Title:

Basic Laboratory Skills

Submodule Title:

General Skills

Approx. Time:

1 hour

Topic:

Dilution Techniques

Objectives:

Upon completion of this module, the participant should be able to:

1. Make single step and multiple step dilutions of concentrated samples and perform calculations taking into account dilution factors.

Instructional Aids:

Handout: "Dilution Techniques"
Pipets
Dilution Blanks

Instructional Approach:

Lecture
Demonstration
Laboratory Practice

References:

Standard Methods for the Examination of Water and Wastewater, 14th Edition

Class Assignments:

Read handout
Participate in laboratory practice sessions

Module No:	Topic: Dilution Techniques
Instructor Notes:	**Instructor Outline:**
Handout: "Dilution Techniques"	Discuss dilution techniques. Demonstrate dilution techniques. Discuss and demonstrate calculations related to dilutions.

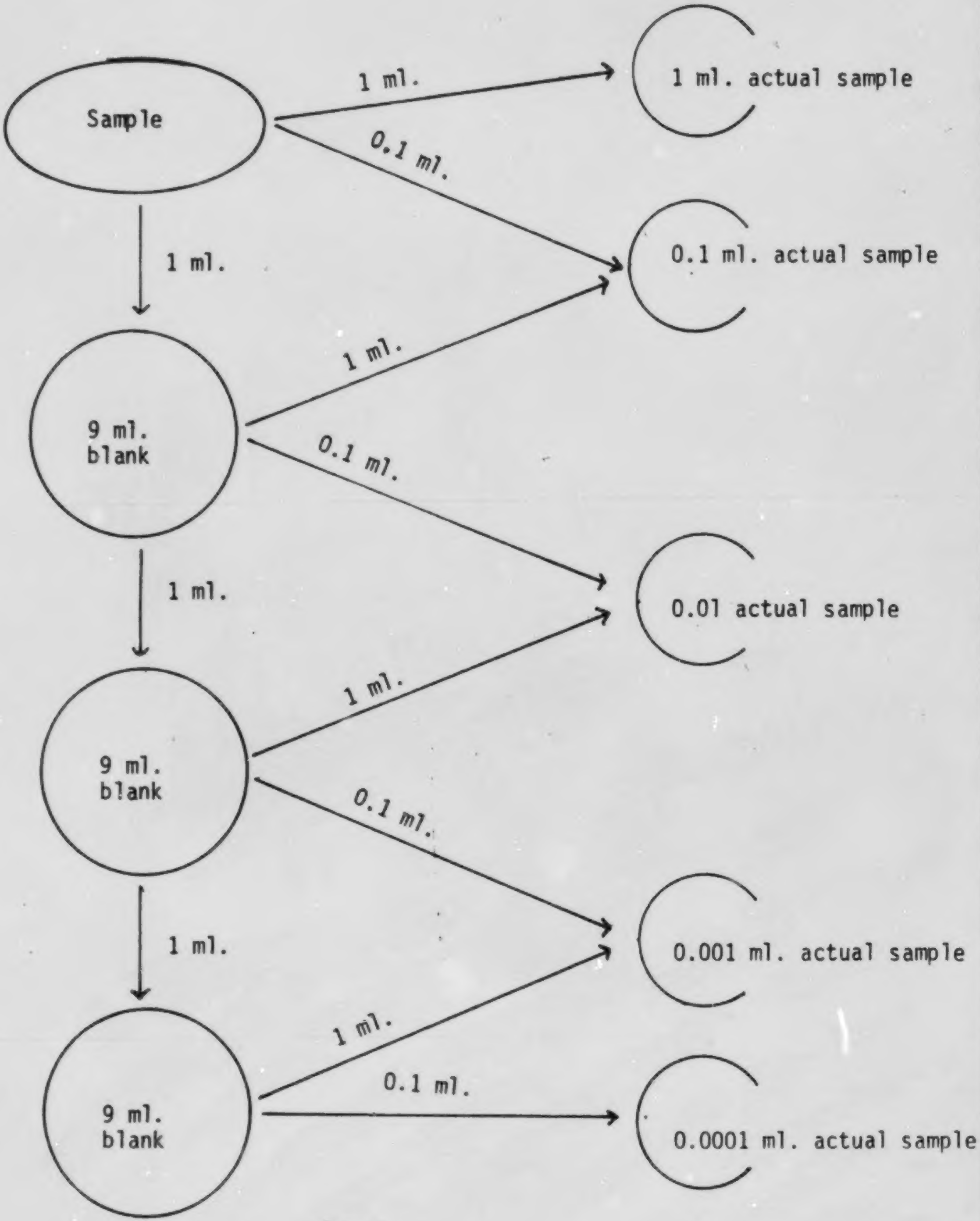
DILUTION TECHNIQUES

Sample dilution is necessary when the concentration of the entity being measured is too great to be determined by the technique employed. By diluting the sample with distilled water, or other solution free of the entity being measured, its concentration can be brought within the range where it can be accurately measured.

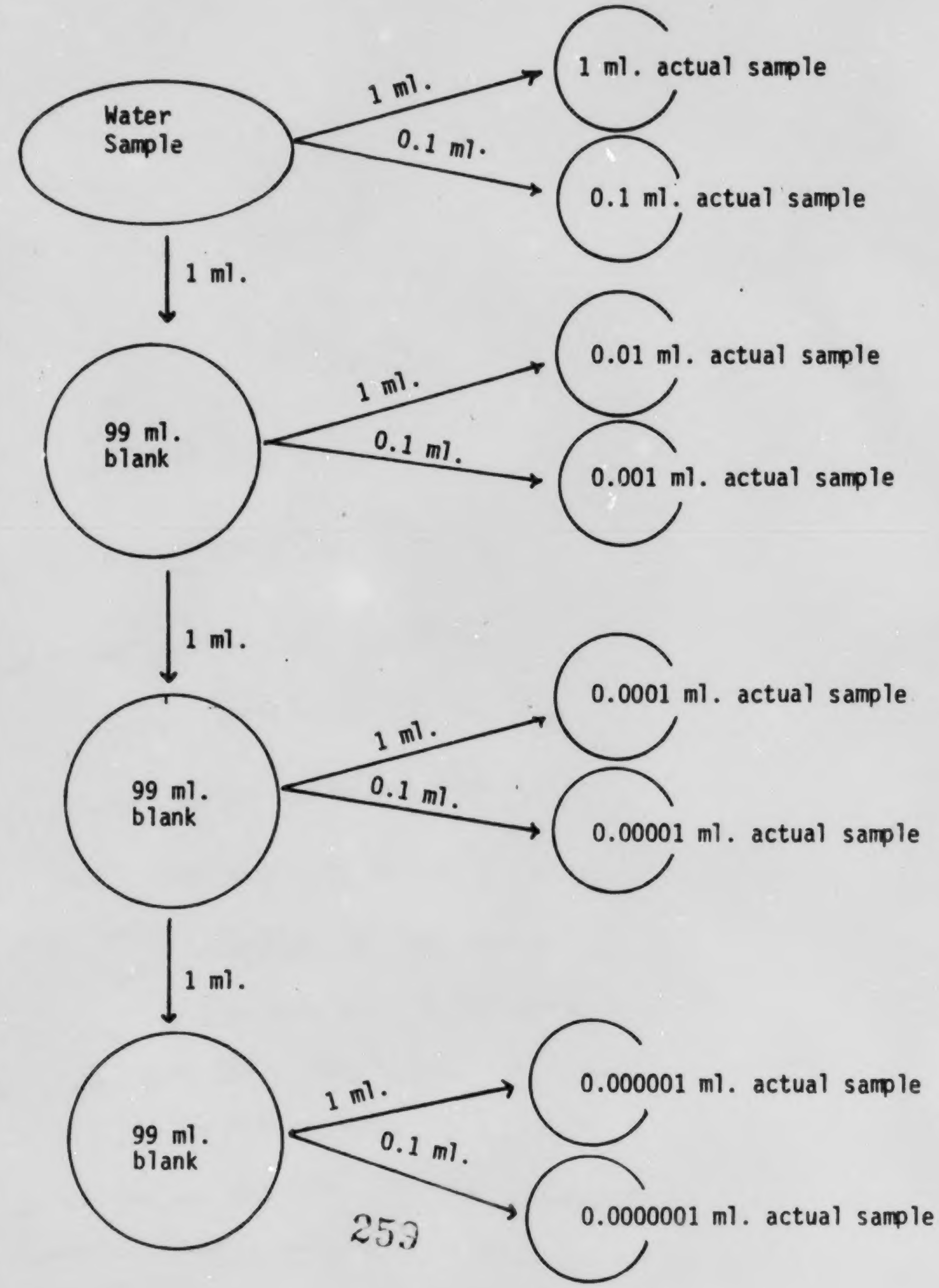
There are two basic methods of dilution, serial dilution and parallel dilution. In serial dilution a known volume is transferred to a dilution blank plus the sample is used for the next transfer 1:10 and 1:100 serial dilutions are shown on pages 75 and 76.

Parallel dilutions are made by always removing a known volume from the sample bottle and using dilution blanks of various sizes to make the proper dilutions. This technique is diagrammed on page 77.

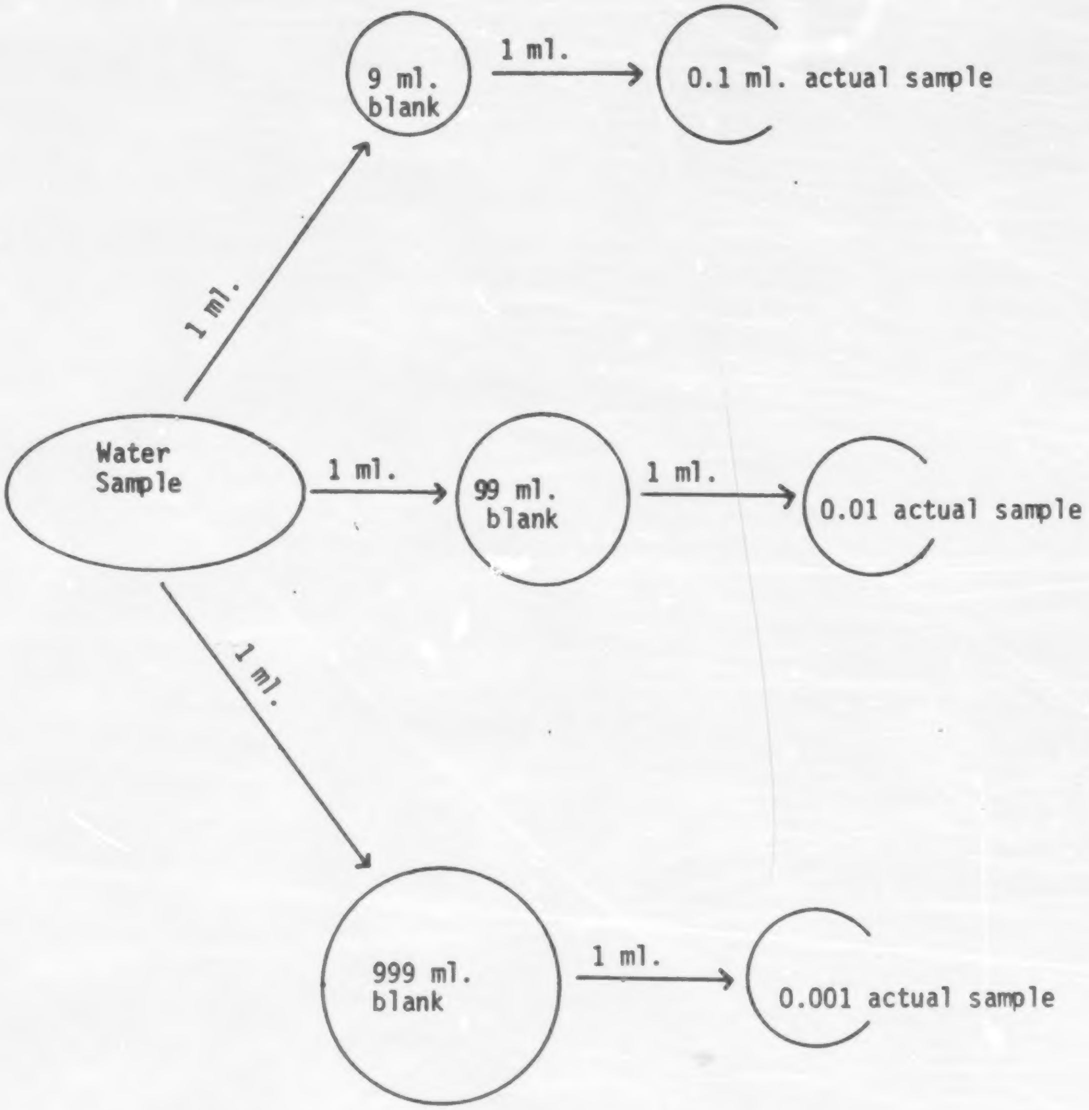
1:10 Serial Dilution Technique


Sample
1 ml.
0.1 ml.
1 ml. actual sample
1 ml.
9 ml. blank
1 ml.
0.1 ml.
0.1 ml. actual sample
1 ml.
9 ml. blank
1 ml.
0.1 ml.
0.01 actual sample
1 ml.
9 ml. blank
1 ml.
0.1 ml.
0.001 ml. actual sample
0.0001 ml. actual sample

1:100 Serial Dilution Technique


Water Sample
1 ml.
0.1 ml.
1 ml. actual sample
0.1 ml. actual sample
1 ml.
99 ml. blank
1 ml.
0.1 ml.
0.01 ml. actual sample
0.001 ml. actual sample
1 ml.
99 ml. blank
1 ml.
0.1 ml.
0.0001 ml. actual sample
0.00001 ml. actual sample
1 ml.
99 ml. blank
1 ml.
0.1 ml.
0.000001 ml. actual sample
0.0000001 ml. actual sample

Parallel Dilution Techniques


9 ml.
blank
1 ml.
0.1 ml. actual sample
1 ml.
Water
Sample
1 ml.
99 ml.
blank
1 ml.
0.01 actual sample
1 ml.
999 ml.
blank
1 ml.
0.001 actual sample

Module No:	**Module Title:** Basic Laboratory Skills
	Submodule Title: General Skills
Approx. Time: 1/3 hour	**Topic:** Incubators

Objectives:

Upon completion of this module, the participant should be able to:

1. State precautions applicable to the care and use of all incubators.

Instructional Aids:

Handout

Instructional Approach:

Lecture
Discussion

References:

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition.
2. Carnegie and Wooley, Laboratory Manual for Sanitary Microbiology and Sanitary Chemistry, EPA, 1975.

Class Assignments:

Read handout

Module No:	**Topic:**
	Incubators

Instructor Notes:	**Instructor Outline:**
1. Include discussions of: a. Installation b. Temperature sensitivity c. Humidity d. Loading e. Cleaning f. Differences	1. Discuss the precautions which must be taken when using gravity convection and forced air inoculators.
2. Include discussion of: a. **Installation** b. Temperature sensitivity c. Loading d. Cleaning e. Differences	2. Discuss the precautions which must be taken when using convection and circulated water bath incubators.

Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
General Skills

Approx. Time:
2 hours

Topic:
Balances

Objectives:

Upon completion of this module, the participant should be able to:

1. State precautions applicable to the care and use of all balances.
2. Identify and use a triple beam balance with a range of 0 - 100 g. with an accuracy of ± 0.01 g. given the balance and appropriate reference material.
3. Identify and use an analytical balance with an accuracy of ± 0.0002 g. given the balance and appropriate reference material.

Instructional Aids:

Analytical Balance
Weights
Beam Balance

Instructional Approach:

Demonstration
Lab

References:

Analytical Quality Control, USEPA, Technology Transfer

Class Assignments:

Participate in laboratory practice sessions

Module No:	Topic: Balances

Instructor Notes:	Instructor Outline:

1. Discuss care and preventive maintenance of balance.
2. a. Discuss and demonstrate the use of a triple beam balance.
   b. Have participants use a triple beam balance.
3. a. Discuss and demonstrate the use of an analytical balance.
   b. Have participant weigh an object on an analytical balance.
   c. Have participant weigh an object on two different analytical balances. Compare the weights. Discuss the consequences of the results.
4. Discuss the use of other types of balances. Ex. electronic

Module No:	**Module Title:** Basic Laboratory Skills
	Submodule Title: Chemistry Skills
Approx. Time: 1 hour	**Topic:** Analytical Analysis

Objectives:

Upon completion of this module, the participant should be able to:

1. Differentiate between volumetric gravimetric and colorimetric analysis.
2. Differentiate between precision and accuracy.

Instructional Aids:

Volumetric glassware, filtration setup
Spec. 20 of filter photo meter
Overheads
1. Precision and accuracy
Handouts
1. Laboratory analysis
2. Precision and accuracy

Instructional Approach:

Lecture
Demonstration

References:

Simplified lab procedure for Wastewater Examination, WPCF, 1971.
Analytical Quality Control, USEPA TEchnology Transfer

Class Assignments:

Read handout

Module No:	Topic: Analytical Analysis

Instructor Notes:	Instructor Outline:
Handout: Laboratory Analysis	1. Discuss volumetric analysis, gravimetric analysis, colorimetric analysis.
	2. Demonstrate an example of each type of analysis.
Show using a known volume and concentration to determine the concentration of second known volume. Show filtration and weighing. Show the development of a color in proportion to concentration.	
Overheads Presicision and Accuracy	3. Define Precision and Accuracy
Handout: Precision and Accuracy	Discuss precision and accuracy and how they relate to average and standard deviation.

LABORATORY ANALYSIS

The laboratory analysis of wastewater deals with the detection and quantitative estimation of the substances present in wastewater and the effects of these substances on the treatment process. In one type of analysis known as "qualitative analysis", the operator sets out to detect the different substances that may be present in the wastewater being tested. In "quantitative analysis", the operator attempts to determine exact amounts, by weight or by volume, of the various substances in a known weight or volume of the wastewater sample. Quantitative analyses are made volumetrically, gravimetrically, or colorimetrically.

Volumetric Analysis

In laboratory procedures classified as volumetric analyses, the operator measures the amount of a solution of known concentration that reacts quantitatively with a particular substance in the solution of a weighed or otherwise measured portion of the original sample. The weight of the material being sought is found indirectly from the amount of the known (standard) solution that is required. The means of detecting the completion or "end-point" of the volumetric reaction is the indicator. The process of finding the amount of the standard solution required is called a "titration".

Gravimetric Analysis

In laboratory procedures classified as gravimetric analyses, the operator measures the sample of wastewater or sludge and then isolates and weighs an element or one of its compounds. Examples of the gravimetric type of analyses are total solids (residue on evaporation) and volatile solids and suspended solids.

Colorimetric Analysis

Colorimetric methods of analyses have been developed for several determinations in an effort to find faster, more economical, and convenient ways of obtaining quantitative laboratory data. For a colorimetric method to be quantitative, it must form a compound with definite color characteristics which are directly proportional to the concentration of the substance being measured. Colorimetric measurements may be made in a wide range of equipment. The wastewater treatment plant operator may use standard color-comparison tubes, photoelectric colorimeters, or spectrophotometers. Each has its place and particular application in wastewater analysis. Color comparison tubes, sometimes referred to as Nessler tubes, have been standard equipment for making colorimetric measurements for many years. Precise work with color comparison tubes requires the use of tubes of matched size. The main difficulty with their use is that the standard color solutions often are unstable and every time a determination has to be made it becomes necessary to prepare a series of fresh standards. The use of color tubes and standards is being replaced rapidly by the photoelectric and spectrophotometric methods largely because of convenience and accuracy.

ACCURACY AND PRECISION

Accuracy is defined as the closeness of a measurement or series of similar measurements to the true value of the quantity measured.

In contrast, precision or repeatability might be defined as the closeness of a number of measurements to a common value, but not necessarily the true value. Precision is desirable but its attainment is not proof that an accurate series of measurements has been made, since constant sources of error may enter into all of the measurements in a series. These errors might fall into one of two classes, some being determinate and others indeterminate. The determinate errors may be discovered, and corrected for or eliminated; while the indeterminate errors essentially are obscured and unknown.

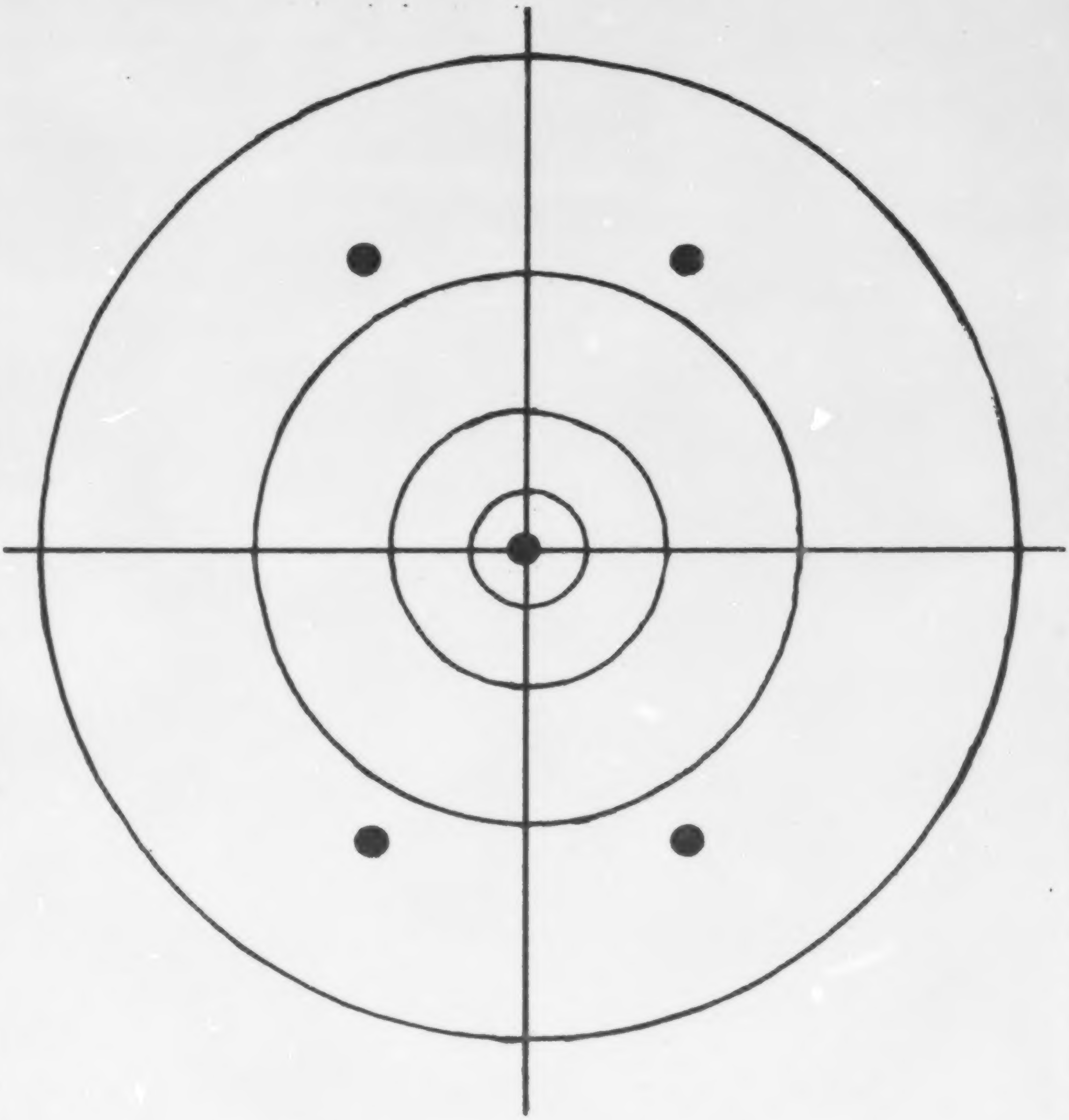
Determinate errors may be:

1. Personal errors due to factors for which the operator is responsible, such as neglecting to read a buret properly, inability to identify color changes, failure to mix volumetric solutions completely, or mis-reading values marked on small weights.
2. Instrumental errors due to the instruments. Imperfect weights, volumetric glassware, and balances are sources of instrumental error.
3. Errors in method, including those due to such things as the use of an improper temperature or time of drying of a solids sample.

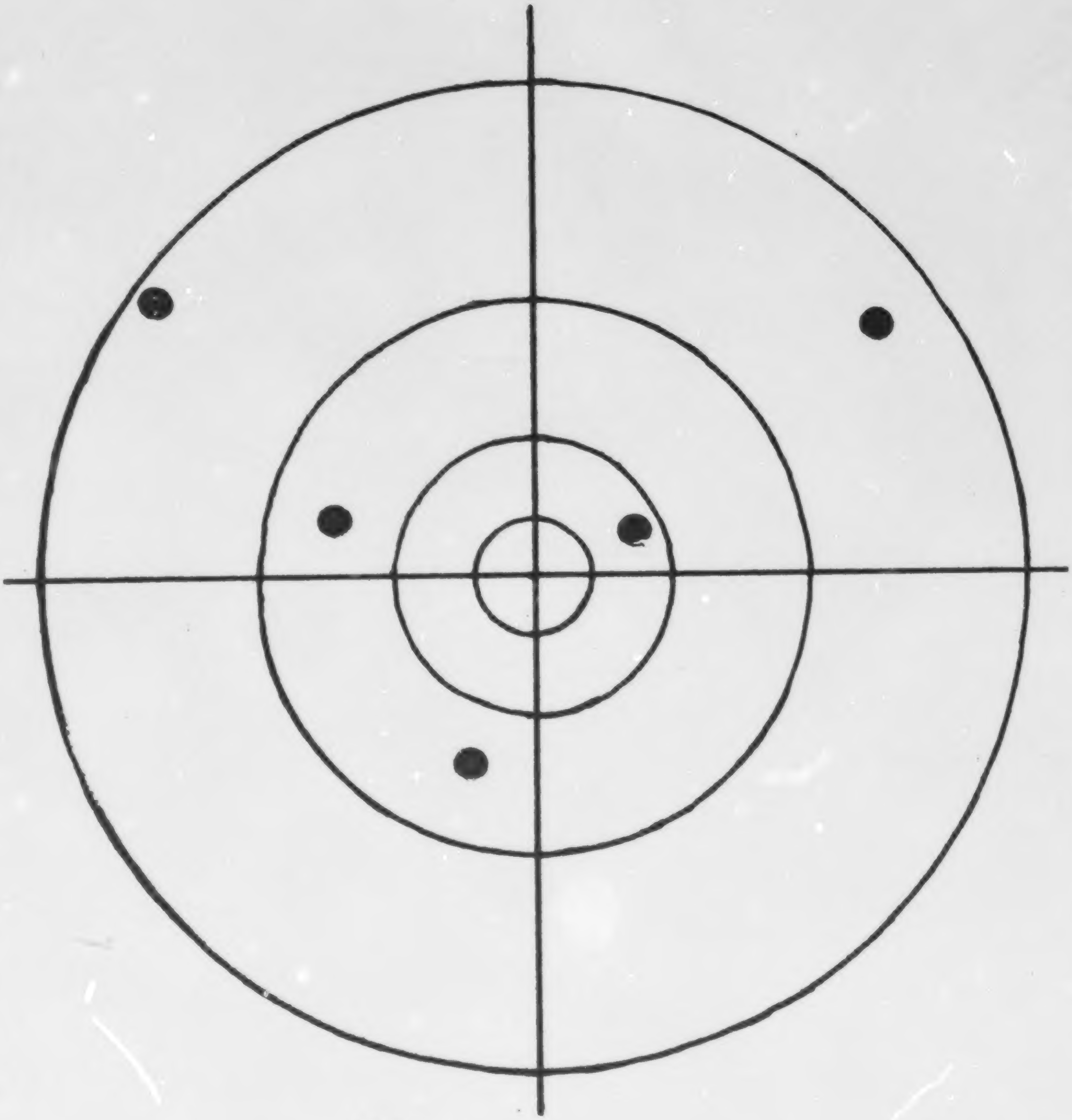
In general, no laboratory result should be rejected except for an obvious source of error. Measurements that vary widely from the mean (or average) may be omitted when determining an average if a reasonable explanation is given. For instance, in a series of four parallel observations or determinations, if one of the four is greatly different from the other three, it might be omitted.

In any measurement only one uncertain figure should be retained. An uncertain figure is the result of an estimate between division on a scale. For example, on a buret which is calibrated only to tenths of ml, the reading would be estimated to the nearest hundredth. Weights in grams should be recorded with four figures to the right of the decimal point (for example, 4.3267 g). Following the rule that only one uncertain figure is retained in recording a measurement, the numbers thus set down are considered to be significant figures. In rounding off measured or computed quantities to the proper number of significant figures 1 should be added to the last significant figure in the next position is 5 or greater. For example, in weighing 4.32567 g would be rounded off to 4.3257 g.

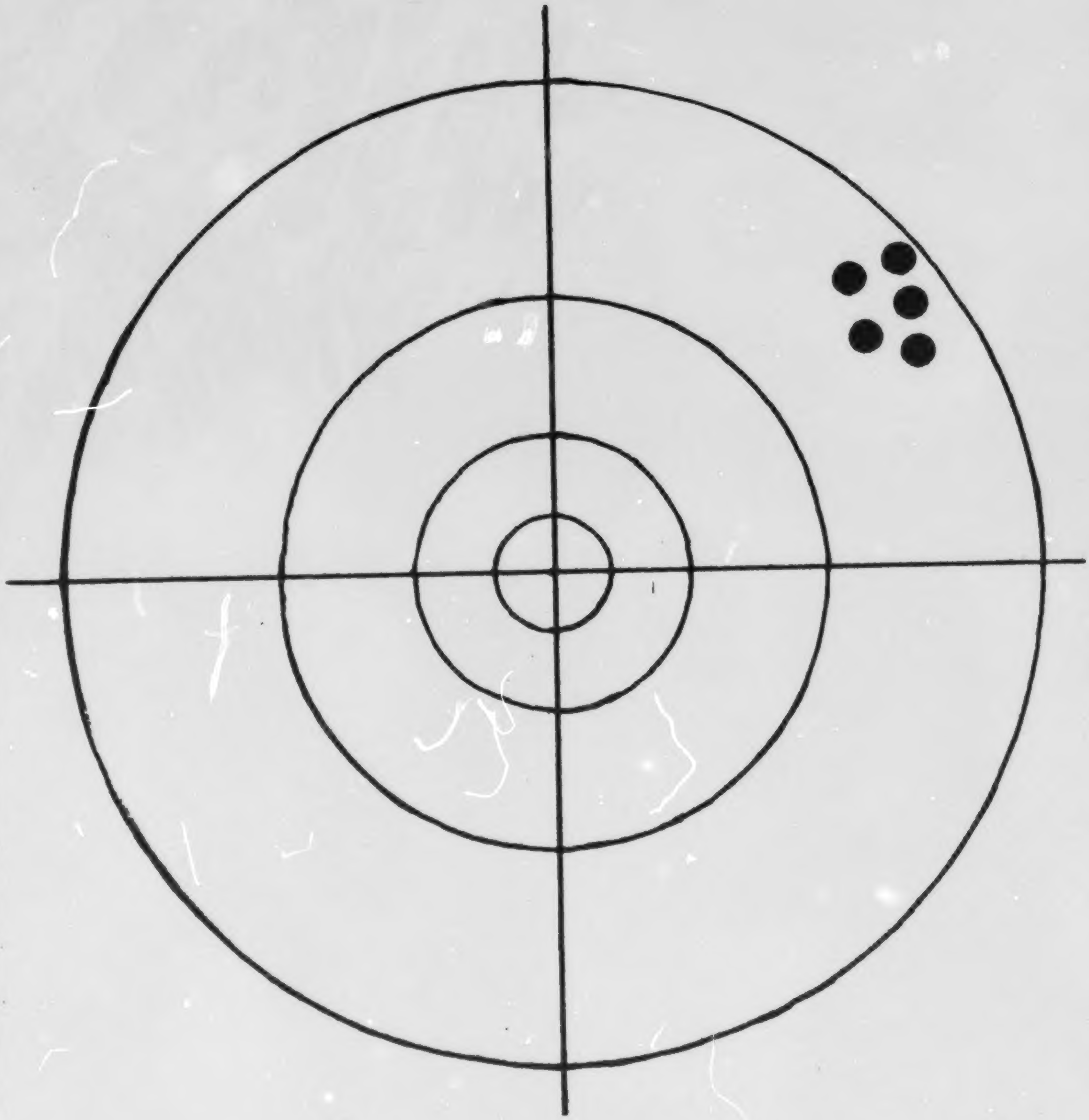
HIGH ACCURACY LOW PRECISION



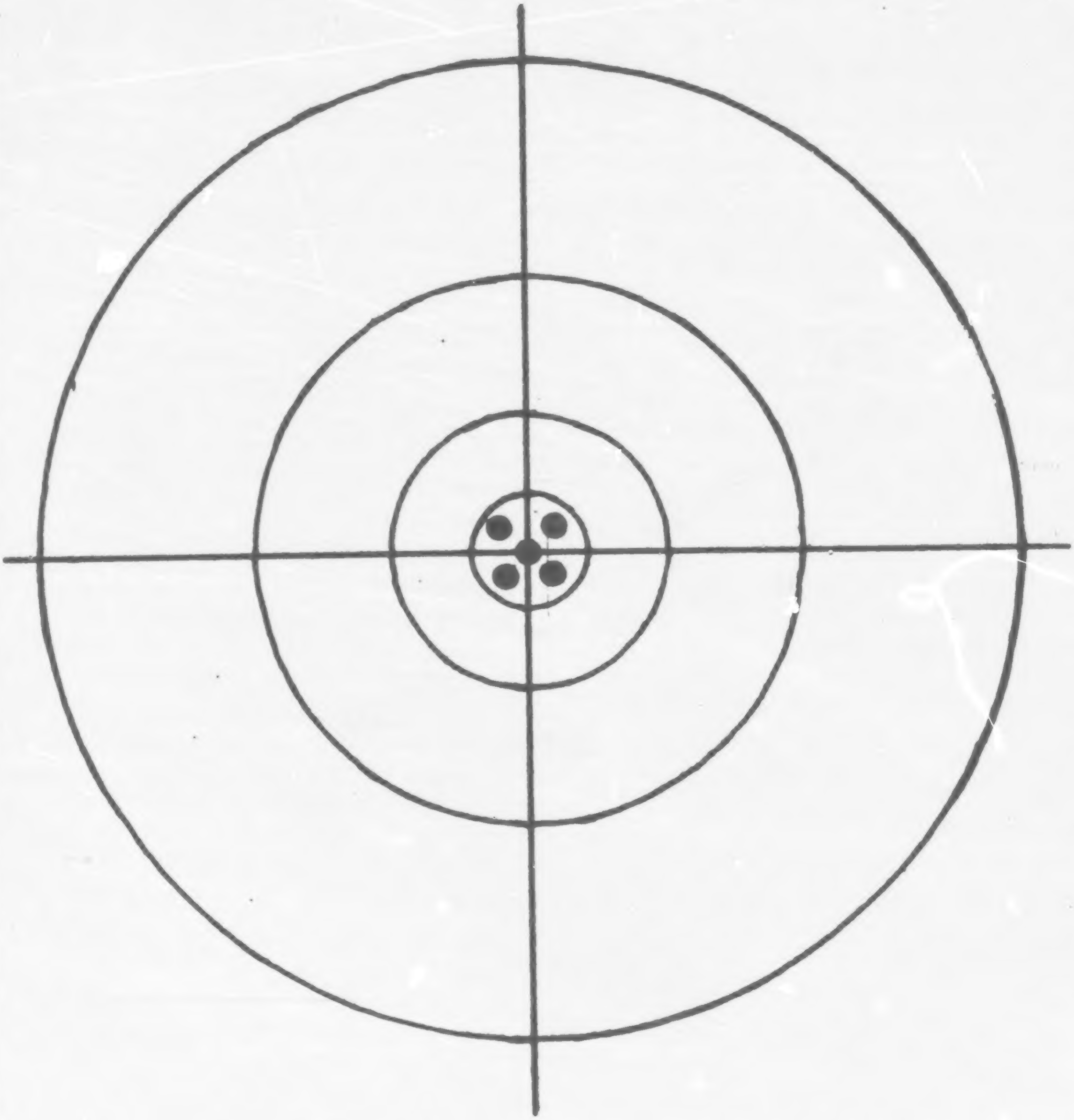
LOW ACCURACY LOW PRECISION



LOW ACCURACY HIGH PRECISION



HIGH ACCURACY HIGH PRECISION



Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
Chemistry Skills

Approx. Time:
3 hours

Topic:
Volumetric Glassware

Objectives:

Upon completion of this module, the participant should be able to:

1. Demonstrate the proper use of the following types of volumetric glassware: Buret, volumetric flask, pipet.
2. Indicate the difference between glassware calibrated to contain and to deliver.
3. Conduct a titration of a strong acid with a strong base using a color end point using proper volumetric technique.

Instructional Aids:

Handout: Volumetric Glassware
Volumetric glassware
Titration setup

Instructional Approach:

Lecture
Demonstration
Lab

References:

Standard Methods, 14th Edition
Analytical Quality Control, USEPA, Technology Transfer

Class Assignments:

Read Handoug
Participate in laboratory practice session

Module No:	Topic: Volumetric Glassware

Instructor Notes:	Instructor Outline:
Titration Dilute 10 ml. of 1 N H_2SO_4 to 100 ml. and titrate with 0.1 N NaOH.	1. a. Demonstrate the proper use of a durey volumetric flask and pipet. b. Conducting a titration.
	2. Discuss use of glassware calibrated to contain and to deliver. Indicate when each is to be used.
(S.P. Duopette)	Show a pipet calibrated to contain and to deliver.
1 N H_2SO_4 acid .1 N NaOH Base Phenolphythalein end point.	3. Have participant practice titration technique by diluting an acid and titrating it with a base using a color endpoint.
Handout: Volumetric Glassware	

VOLUMETRIC GLASSWARE

BURETTES

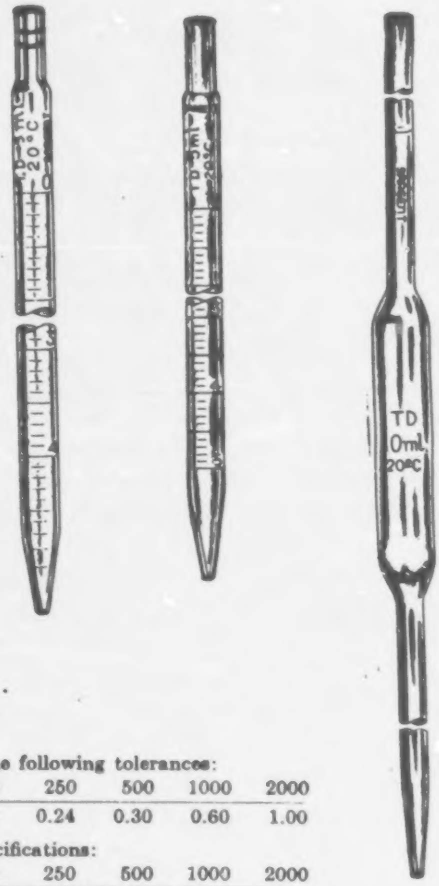
Burette Accuracy Tolerances

Delivery, ml	10	25
Class A (Precision Grade)	±0.02	±0.03
Other than Class A	±0.04	±0.06
Delivery, ml	50	100
Class A (Precision Grade)	±0.05	±0.10
Other than Class A	±0.10	±0.20

Automatic burettes with overflow orifice for filling are very convenient for rapid repetitive titrations but cannot be relied upon to deliver within the accuracy tolerances shown in the table above because of the somewhat inconsistent establishment of initial level at the overflow aperture.

Schellbach burettes, which are considered very easy to read, cannot be guaranteed to fall strictly within the stated tolerances because of personal variables in reading this type of burette.

pipette



Volumetric Flasks

Flasks not described as Class A are calibrated at 20°C with the following tolerances:

Capacity, ml	10	25	50	100	200	250	500	1000	2000
Tolerance, ± ml	0.06	0.06	0.10	0.16	0.20	0.24	0.30	0.60	1.00

Flasks designated "Class A" are calibrated to meet N.B.S. specifications:

Capacity, ml	10	25	50	100	200	250	500	1000	2000
Tolerance, ± ml	0.03	0.03	0.05	0.08	0.10	0.12	0.15	0.30	0.50

PIPETTES

Tolerances For Analytical Grade Pipettes

Transfer Pipettes				*Measuring and Serological Pipettes*	
Size	*Tolerance*	*Size*	*Tolerance*	*Size*	*Tolerance*
1 ml	±0.012 ml	15 ml	±0.06 ml	0.1 ml	±0.005 ml
2 ml	±0.012 ml	20 ml	±0.06 ml	0.2 ml	±0.008 ml
3 ml	±0.02 ml	25 ml	±0.06 ml	1 ml	±0.02 ml
4 ml	±0.02 ml	50 ml	±0.10 ml	2 ml	±0.02 ml
5 ml	±0.02 ml	100 ml	±0.16 ml	5 ml	±0.04 ml
10 ml	±0.04 ml	200 ml	±0.20 ml	10 ml	±0.06 ml

Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
Chemistry Skills

Approx. Time:
3 Hours

Topic:
Standardization of Reagents

Objectives:

Upon completion of this module, the participant should be able to:

1. Indicate the relationship between normality and volume of two neutralizing solutions [illegible] the equivalence point.
2. Calculate the weight of solute needed to make a solution of stated normality given a list of equivalent weights.
3. Standardize a solution given a neutralizing primary standard, balance and volumetric glassware.

Instructional Aids:

Titration setup

Instructional Approach:

Lab

References:

Standard Methods, 14th Edition

Class Assignments:

Module No:

Topic:
Volumetric Analysis

Instructor Notes:

Instructor Outline:

1. a. Explain the equation ml x N = ml x N

   b. Work examples using data from topic on volumetric glassware.

2. a. Discuss how the normality of a solution can be determined. Give the equivalent weight of the solute, weight of solute and volume of solution.

   b. Work examples

KHP
EWT =
Base .1 N

3. a. Define primary standard

   b. Have participant weigh out a given amount of primary standard and titrate it with a base.

   c. Have participant calculate the exact normality of the base from the above data.

Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
Chemistry Skills

Approx. Time:
3 hours

Topic:
Colorimetric Analysis

Objectives:

Upon completion of this module, the participant should be able to:

1. Indicate the relationship between concentration and absorbance.
2. Identify the basic components of a Spec 20 or other common laboratory spectrophotometer.
3. Set up, standardize and use a Spec 20 to determine the absorbance of a sample, given a Spec 20, sample, operating instructions and wave length of max absorbance of the sample.
4. Indicate the relationship between absorbance and transmittance.

Instructional Aids:

EPA video tape
Overheads
Handout: "Colorimetric Analysis"

Instructional Approach:

Lecture
Lab

References:

Effluent Monitoring Procedures, Nutrients, USEPA

Class Assignments:

Read handout
Participate in laboratory practice sessions

Module No:	Topic: Colorimetric Analysis

Instructor Notes:	Instructor Outline:
	1. a. Discuss Beer's Law
	b. Demonstrate Beer's Law using nessler tubes and a $KMnO_4$ solution.
Spec 20 Overheads	2. a. Identify the components of a Spec 20.
Handout: Colorimetric Analysis	b. Explain how each component works and what its purpose is in the Spec 20.
EPA video tape	3. a. Demonstrate the use of a Spec 20.
	b. Have participants set up, standardize and use the Spec 20.
	4. Discuss the relationship between absorbance and transmittance.

COLORIMETRIC ANALYSIS

Use of a Spectrophotometer

General Description of Equipment Used in the Process

A. Capital

1. One Bausch and Lomb Spectronic 20 Spectrophotometer
2. One manufacturer's manual for the spectrophotometer
3. Still, or other source of distilled water
4. Hotplate
5. One spectrophotometer cell - A set of cells may be used only if the cells are optically matched. One cell would be used for each solution.

B. Reusable

1. Brush (for cleaning spectrophotometer cell)
2. Laboratory apron
3. Safety glasses
4. One pen or pencil
5. Notebook or data sheet (see page 1-23) for recording data
6. Brush (for dusting spectrophotometer)
7. One 2 liter beaker
8. One 250 ml. beaker
9. One glass stirring rod
10. One 2 liter glass stoppered bottle
11. One visible phototube (Bausch and Lomb catalog number 33-29-71)
12. One infrared phototube (Bausch and Lomb catalog number 33-29-72)
13. One infrared filter (Bausch and Lomb catalog number 33-29-18)

14. Ten soft tissues (for wiping the cells)
15. One plastic squeeze distilled water bottle
16. Sink or 1 liter container for rinsing solutions
17. One 1 cm. cell (to fit the Spectronic 20)

C. Consumable

1. Soap
2. Sodium dichromate, $Na_2Cr_2O_7$
3. Concentrated sulfuric acid, H_2SO_4

Items A4, B7 through B10, and C1 through C3 for cleaning the spectrophotometer cell.

Use of a Spectrophotometer

1. Analysis Objectives:

The user of the attached effluent monitoring procedure will learn how to use the Bausch and Lomb Spectronic 20 Spectrophotometer for making colorimetric measurements.

2. Brief Description of Analysis:

In the field of water pollution analysis, many determinations are based on measuring the intensity of color at a particular wavelength. In general, color is formed in the sample by some sort of preliminary treatment such as distillation or digestion, and then adding a color developing reagent. The intensity of the color formed is related to the amount of material (such as phosphorus) in the sample. As part of the analysis, color is also developed in a series of standards; in each of the standards is a known amount of the material (such as phosphorus) of interest. A calibration curve is made using the color intensities of the individual standards and the corresponding amounts of material present. The amount of material present in the sample is determined using the calibration curve. A Bausch and Lomb Spectronic 20 Spectrophotometer is an instrument used to measure the color intensities of the standards and sample. The word absorbance is associated with the words color intensity; i.e. a sample or standard which has a low color intensity will also have a low absorbance.

A. Equipment Preparation

1. Cell cleaning

   Clean the Bausch & Lomb Spectronic 20 Spectrophotometer test tube cell.

   a. For the rest of this effluent monitoring procedure the abbreviation "Spec 20" will be used.

2. Spec 20 cleaning

   Clean the Spec 20.

   a. It should be free of dust, dirt, and spilled chemicals.

   b. The Spec 20 should be stored in an area where there is no danger that chemicals will be spilled on it.

   c. The plastic cover supplied with the Spec 20 should be covering the instrument whenever it is not in use.

   If the power cord is plugged into a wall outlet, remove it.

3. Phototube

   Check whether the proper phototube is in place.

   a. See Section C for instructions on changing the phototube and inserting the filter.

   b. On the wavelength scale, note that below about 625 nm, the numbers are in black, and that above 625 nm, the numbers are in rec

   c. If the wavelength to be used in the particular phototube (Bausch & Lomb Catalog number (33-29-71) should be used.

   d. If the wavelength to be used is in the red zone, the infra-red phototube (Bausch & Lomb Catalog number 33-29-72) and infra-red filter (Bausch & Lomb Catalog number 33-29-18) should be used.

B. Spec 20

1. Warm up

   Plug the power cord into a wall outlet

   a. 115 V, A.C., 60 Hz

2. Turn the power switch/zero control knob (see figure 1) clockwise, until a click is heard.

   a. The instrument is now turned on.

   b. If there is a pilot light on the instrument, it will also be on.

   c. The sound of the cooling fan may also be heard.

3. Turn the power switch/zero control knob an additional one half clockwise turn.

   a. This will keep the needle from "pegging" during the warm up period.

4. Wait ten minutes

   a. This is the warm up period.

   b. Ten minutes are generally specified in the manufacturer's manual. However, longer warm up periods than those specified generally give better instrument stability.

   c. If the Spec 20 is old, a longer than 10 minute warm up period may be required. Twenty to thirty minutes would be a suitable warm up time.

Operation

1. Assemble the standards and samples whose color intensities are to be measured.

2. Set the wavelength control to the desired setting.

   a. This setting will be specified in the procedure you are using to determine the particular parameter.
   b. Always approach the desired setting by turning the knob clockwise.
3. If the sample holder cover is open, close it.
   a. It should be closed unless a cell is being inserted or removed.
4. Turn the power switch/zero control knob until the needle reads infinite (symbol) absorbance.
   a. Use the absorbance (lower) part of the scale. The other (upper) half of the scale is marked in transmittance.
   b. The words absorbance and color intensity are related; i.e. if a solution has a low color intensity, it will also have a low absorbance.
5. Fill the cell with the blank.
   a. Also sometimes called the zero standard.
6. Empty the cell into the sink.
7. Fill the cell with blank.
8. Empty the cell into the sink.
   a. The cell has now been rinsed twice with solution.
9. Fill the cell with blank.
   a. Three fourths full. Estimate this volume.
10. Thoroughly wipe the outside of the cell with a tissue.
    a. So as to remove finger prints and any spilled solution.
11. Open the sample holder cover.

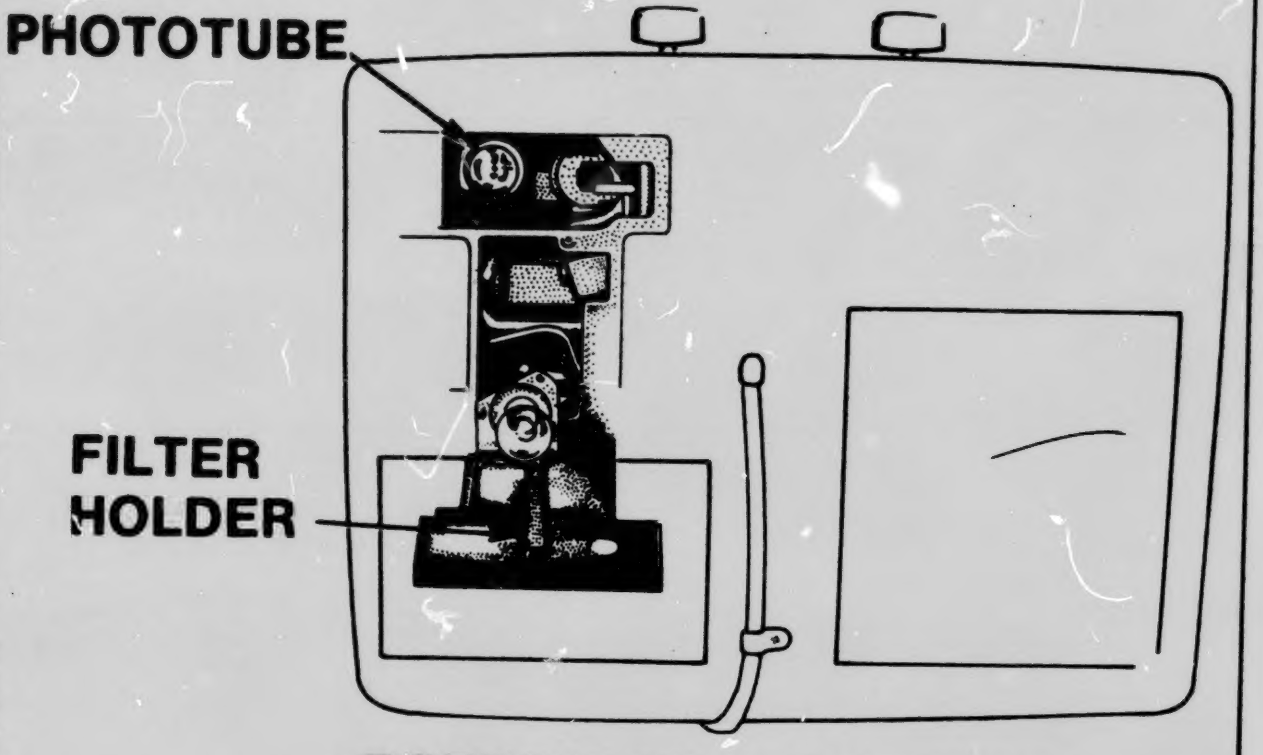
12. Slowly and gently slide the cell down into the sample holder as far as it will go.
    a. Do not force the cell down.
    b. The needle will move away from the infinite absorbance setting.
13. Slowly rotate the cell until the white vertical line on the cell is in line with the ridge on the edge of the sample holder (see figures 2 and 3).
14. Close the sample holder cover.
15. Turn the light control knob until the needle reads zero absorbance.
    a. Use the absorbance scale for all of the readings.
16. Record an absorbance of zero and a concentration of zero for this solution.
    a. An example data sheet is on page 23.
17. Raise the sample holder cover.
18. Slowly remove the cell.
    a. No solution should be spilled on the inside of instrument.
19. Close the cover.
    a. The needle should return to the infinite absorbance setting. If it does not, reset it with the power switch/zero control knob.
    b. If it was necessary to reset the infinite absorbance reading, repeat steps 11 through 15.
20. Empty the contents of the cell into the sink.
21. Fill the cell with tap water.
22. Empty it into the sink.

23. Fill the cell with tap water.
24. Empty it into the sink.
25. Fill the cell with distilled water.
26. Empty it into the sink.
27. Fill the cell with distilled water.
28. Empty it into the sink.
29. Fill the cell with the next solution whose color intensity (absorbance) is to be measured.
    a. In a set of standards, the absorbance of the lowest concentration standard is measured second, and so on, to the highest concentratio standard.
30. Empty it into the sink.
31. Fill the cell with the same solution again.
32. Empty it into the sink.
33. Fill the cell three fourths full with the same solution.
34. Thoroughly wipe the outside of the cell with a tissue.
    a. So as to remove finger prints and any spilled solution.
35. Open the sample holder cover.
36. Slowly and gently slide the cell down into the sample holder as far as it will go.
    a. Do not force the cell down.
    b. The needle will move away from the infinite absorbance setting.
37. Slowly rotate the cell until the white vertical line on the cell is in line with ridge on the edge of the sample holder (see figure 2 & 3).
38. Close the sample holder cover.

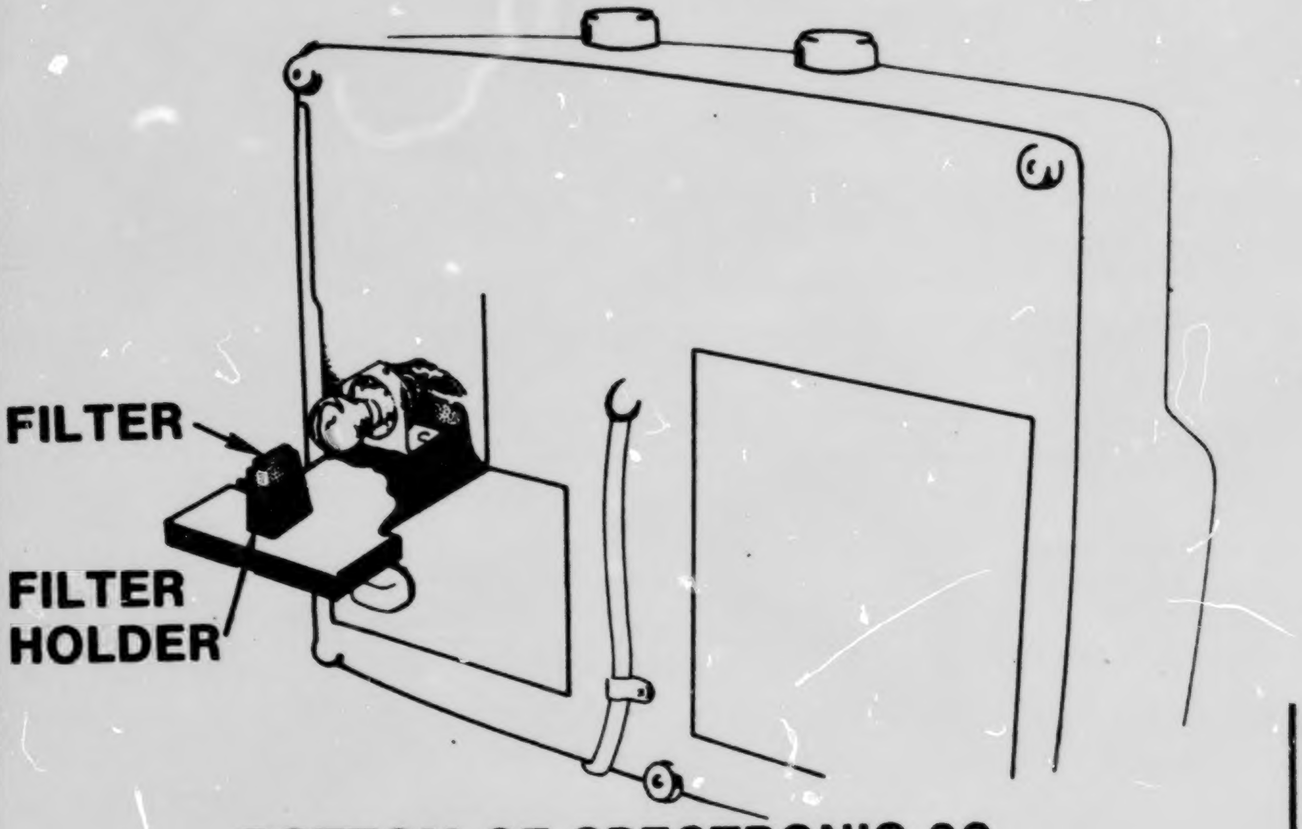
39. Record the absorbance and concentration of this solution.
    a. While looking at the absorbance scale, note that in some parts of the scale, the third place to the right of the decimal will be an estimated number, while in other parts, the second place will be an estimated number.
    b. Absorbance values of greater than 0.7 are considered to be inaccurate. For this reason, about three sample dilutions are usually done so that at least one will give an absorbance of less than 0.7. If one of the standards happens to have an absorbance of greater than 0.7, it should not be used.
    c. If a great number of measurements are to be made at a particular time (e.g., a great number of phosphorus absorbancies are to be measured), steps 4 through 15 should be repeated every fifth measurement.
    d. Recall that step 4 was done with no cell in the instrument.
    e. This is an insurance against "drifting" of the setting.
40. Using each of the rest of the standards in sequence, and samples, repeat steps 17 through 39.
41. Repeat steps 17 through 28.
42. Store the cell until it is again needed.
43. Turn the power switch/zero control knob slowly counter clockwise until a click is heard.
    a. If the instrument has a pilot light, it will go out.
    b. The Spec 20 is turned off.
44. If a plastic cover was supplied with the Spec 20, it should now be replaced.

C. Phototube Changing

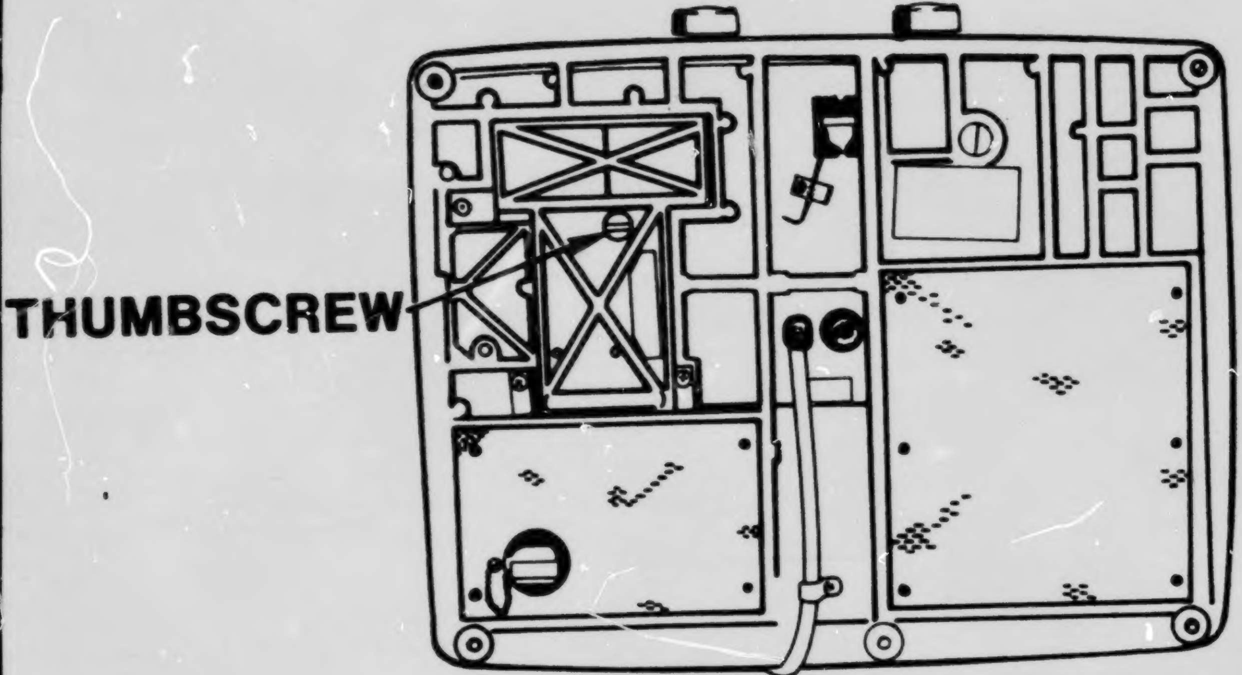
1. Turn the power switch/zero control knob slowly counter-clockwise until a click is heard.
   a. The instrument may already be turned off.
   b. If the instrument has a pilot light, it will go out.
   c. The Spec 20 is turned off.
2. Remove the power cord from the wall outlet.
   a. The power cord may already be removed from the wall outlet.
3. Tilt the Spec 20 away from you.
   a. The Spec 20 should be standing on its back.
   b. The bottom of the instrument is facing you.
   c. This position is somewhat unsteady. Be careful not to knock the instrument over.
4. Steady the instrument with one hand.
5. Loosen the thumbscrew with the other hand (see figure 4).


PHOTOTUBE
FILTER HOLDER

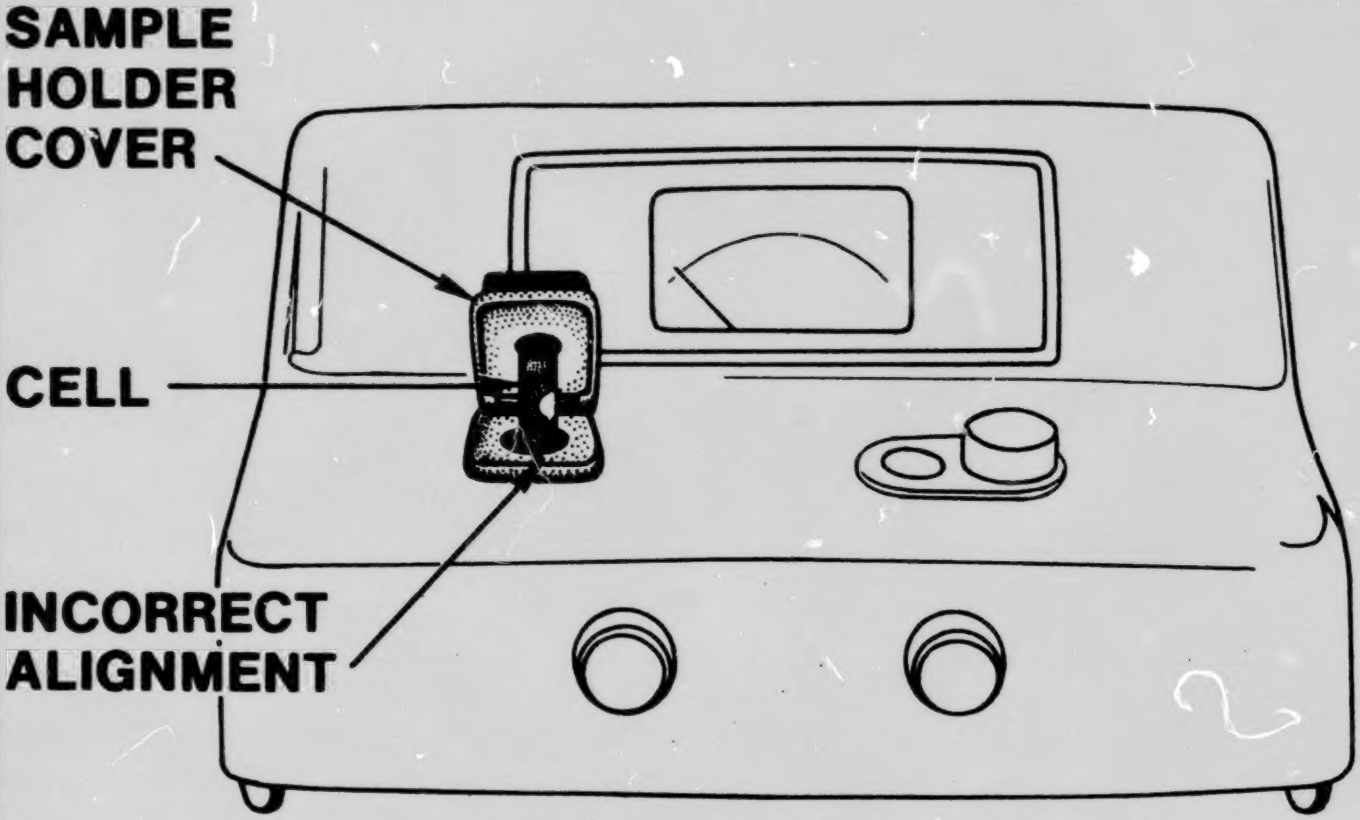
BOTTOM OF SPECTRONIC 20

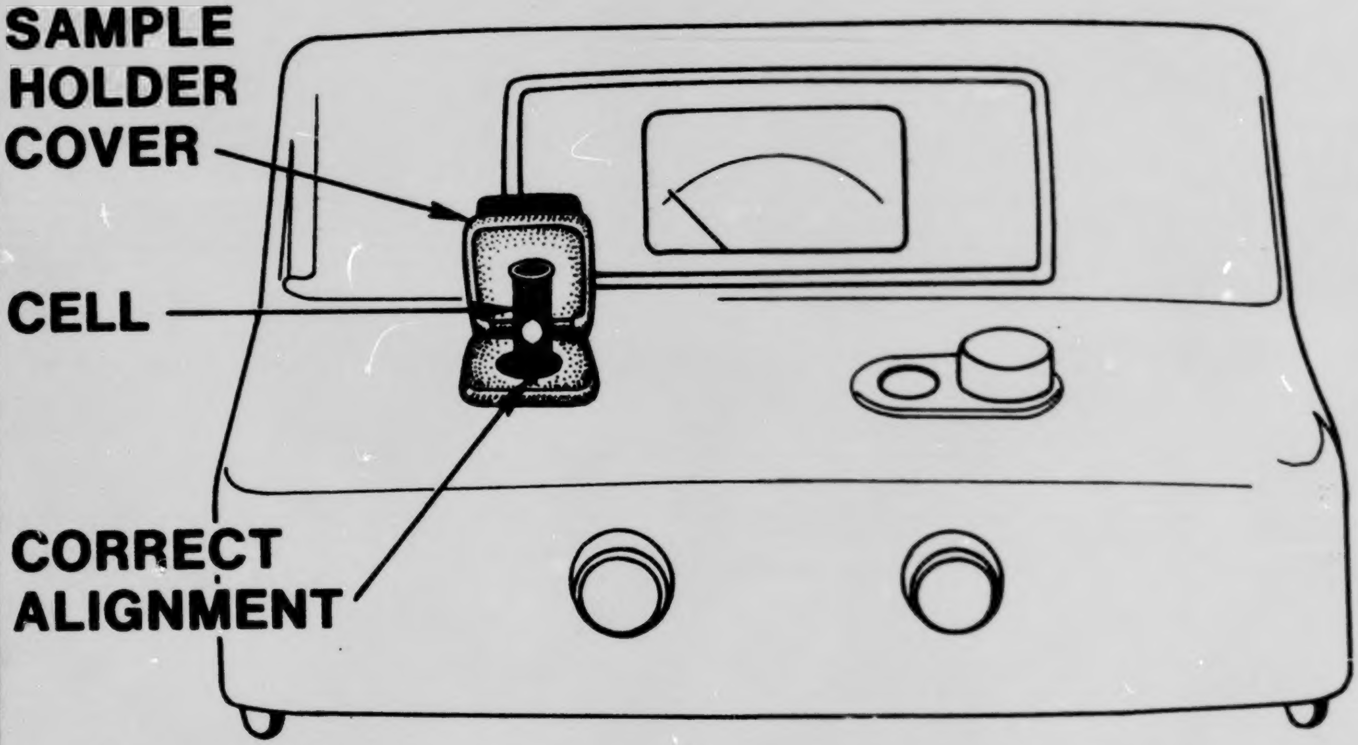

FILTER
FILTER HOLDER

BOTTOM OF SPECTRONIC 20


THUMBSCREW

BOTTOM OF SPECTRONIC 20


SAMPLE HOLDER COVER
CELL
INCORRECT ALIGNMENT


SAMPLE HOLDER COVER
CELL
CORRECT ALIGNMENT

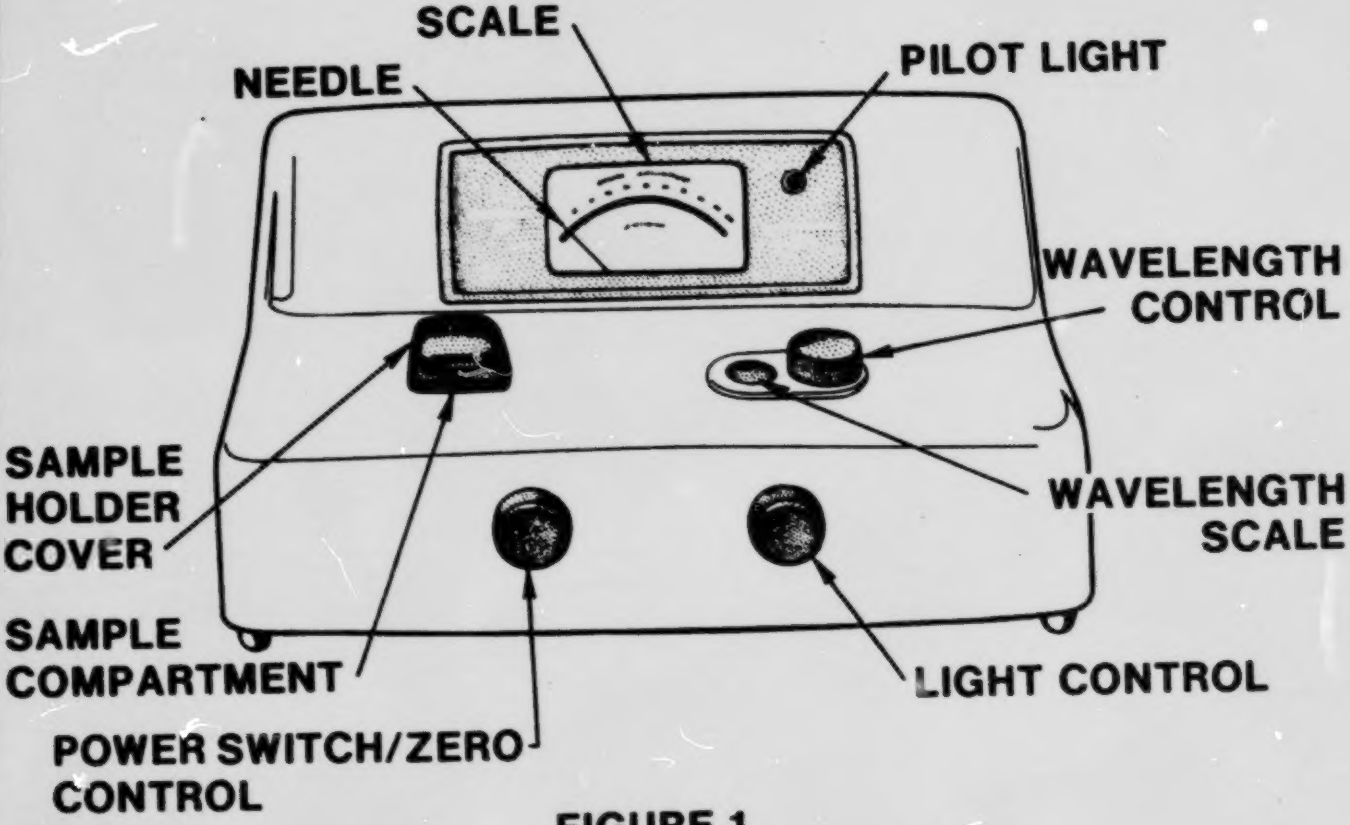

SCALE
NEEDLE
PILOT LIGHT
WAVELENGTH CONTROL
WAVELENGTH SCALE
SAMPLE HOLDER COVER
SAMPLE COMPARTMENT
POWER SWITCH/ZERO CONTROL
LIGHT CONTROL

FIGURE 1

Module No:

Module Title:

Basic Laboratory Skills

Submodule Title:

Chemistry Skills

Approx. Time:

1 hour

Topic:

Standard Curves

Objectives:

Upon completion of this module, the participant should be able to:

1. Prepare a standard curve by plotting absorbance vs. concentration of standard solutions and use the standard curve to determine the concentration of an unknown sample given its absorbance.

Instructional Aids:

Handout: "Standard Curves

Instructional Approach:

Lab

References:

Effluent Monitoring Procedures, Nutrients

Class Assignments:

Read handout

Module No:	Topic: Standard Curves
Instructor Notes:	Instructor Outline:
Handout Standard Curves	1. a. Discuss the use of standard curves. b. Demonstrate the make up of the curve and use of it to determine the concentrati of a solution. c. Work handout d. Have participants make up a series of known standards and determine the concentration of an unknown using techniques from the topics Colorimetric Analysis and Standard Curves.

Preparation of Calibration Graphs

1. Analysis Objectives:

The learner will prepare a calibration graph and will use it to determine the concentration of a chemical constituent in a sample of sewage effluent The word concentration means how much of the chemical constituent is present in a certain amount of sample; 1.0 milligram/liter is an example value of concentration.

2. Brief Description of Analysis:

In the field of water pollution analysis, calibration graphs are commonly used in two areas: Absorbance and transmittance measurements. In the first case, energy is absorbed by some chemical constituent in a solution. The amount of energy absorbed or transmitted can be related to the quantity of chemical constituent in a water sample by means of a calibration graph. Examples of absorbance measurements are colorimetric determinations, such as nitrate or phosphate using a spectrophotometer, and the determination of mercury or iron using atomic absorption. Example of transmittance measurements are the determinations of sodium or potassium using flame photometry.

Two things must be done in order to prepare a calibration graph. A series of standards must be prepared. A standard is a solution which contains a known amount of the same chemical constituent which is being determined in the sample. Secondly, the absorbance or transmittance of these standards must be measured.

In order to actually determine how much of the chemical constituent is in the sample, the absorbance or transmittance of the sample must first be determined. The amount of chemical constituent is then read from the calibration graph.

For the sake of simplifying the instruction, absorbance values only will be used in the following procedure.

A. Graph Paper

1. General Comments
    - a. Remove the page containing figure 1.
    - b. Lay it on a desk or any other place where it will be convenient for you to write on it.
        1. For the remainder of this procedure, you will actually use figure 1 and some example absorbance and concentration values to prepare a calibration graph. Additional figures are also included to demonstrate the instructions.
        2. You will have to furnish your own piece of graph paper when you want to prepare other calibration graphs.
2. Labeling the graph paper
    - a. Draw two lines on figure 1 so that it looks like figure 2.
        1. Use a pencil, since you may have to do some erasing during the preparation of the calibration graph.
    - b. Label figure 1 so that it looks like figure 3.
        1. mg/l stands for milligrams per liter. It is an expression of concentration. If the amount of chemical constituent present in the sample is extremely small, the label mg/l

(micrograms per liter) might be used. A stands for absorbance.

2. The mg/l line is a horizontal line. It is called the X axis, or abscissa. The A line is called the Y axis, or ordinate.

c. Examine the example absorbance and concentration values in the column below.

1.

mg/l	A
0.0	0.000
5.0	0.060
10.0	0.120
20.0	0.250
30.0	0.340
40.0	0.470
50.0	0.590

A of sample = 0.180

2. It is data for a series of standards.

3. Each pair of values (e.g. 5.0 and 0.060) represents a point on the graph.

4. Later, you will complete the calibration graph by drawing a straight line through the seven points.

d. Note that the mg/l value is 0.0 and the highest is 50.0.

e. Mark the mg/l axis on figure 1 so that it looks like figure 4.

1. Note that the entire length of the mg/l axis was used. Always use as much of this line as is convenient. Do not, for example, use only one-half of the mg/l axis to mark off the values.

    2. Also note that each of the large squares is marked as a whole number of mg/l.
    3. Two of the smaller squares equal 1 mg/l.
  f. Note that the lowest A value is 0.000 and the highest is 0.590.
    1. It is generally not considered good practice to have A values greater than 0.6 or 0.7.
  g. Mark the A axis on figure 1 so that it looks like figure 5.
    1. Note that the entire length of the A axis was used. Always use as much of this line as convenient. Do not, for example use only one-half of the A axis to mark off the values.
    2. Also note that each of the large squares is marked as a whole number of A units.
    3. One of the smaller squares equals 0.01 A units.
    4. If transmittance measurements were being made, the Y axis or ordinate, would be marked T. T axes are always marked from 0 bottom of axis) to 100 (top of axis).

3. Drawing the calibration graph
  a. On figure 1 draw a vertical line from the 50.0 mg/l point of the mg/l axis to the top of the graph.
    1. Figure 1 should now look like figure 6.
  b. On figure 1 draw a horizontal line from the 0.590 point of the A axis to the right side of the graph.
    1. Figure 1 should now look like figure 7.
    2. The intersection of these two lines is the point represented by a concentration of 50.0 mg/l and an absorbance of 0.590.

c. Using the same technique as in 1 and 2 above, locate the next five points on figure 1.

   1. The point located at 0.0 and 0.000 is at the intersection of the mg/l and A axes.

   2. Your graph should now look like figure 8. Some analyses may require more than five points.

d. Lay your ruler on figure 1.

   1. So one end of it lies at the 0.0 - 0.000 point, and at the 50.0 - 0.590 point.

e. Look along the edge of the ruler.

   1. The other five points (represented by the intersections of the horizontal and vertical lines do not all lie along the edge of the ruler.

f. Draw a line between the 0.0 - 0.000 and the 50.0 - 0.590 points.

   1. Note that some of the points lie slightly above the line, some lie slightly below the line, and some lie on the line. If one point is considerably off the line, some error in preparing the particular standard was probably made.

   2. This is the line of best fit for the seven points. Always draw the line of best fit when preparing calibration graphs.

   3. The calibration graph is now complete.

   4. Figure 1 should now look like figure 9.

   5. After you have prepared a few calibration graphs, you will find that you won't have to draw the horizontal and vertical lines to locate the points. You'll be able to move your pencil

along the graph paper and put dots at the appropriate points. You'll then draw the line of best fit through them to the 0.0 - 0.000 point.

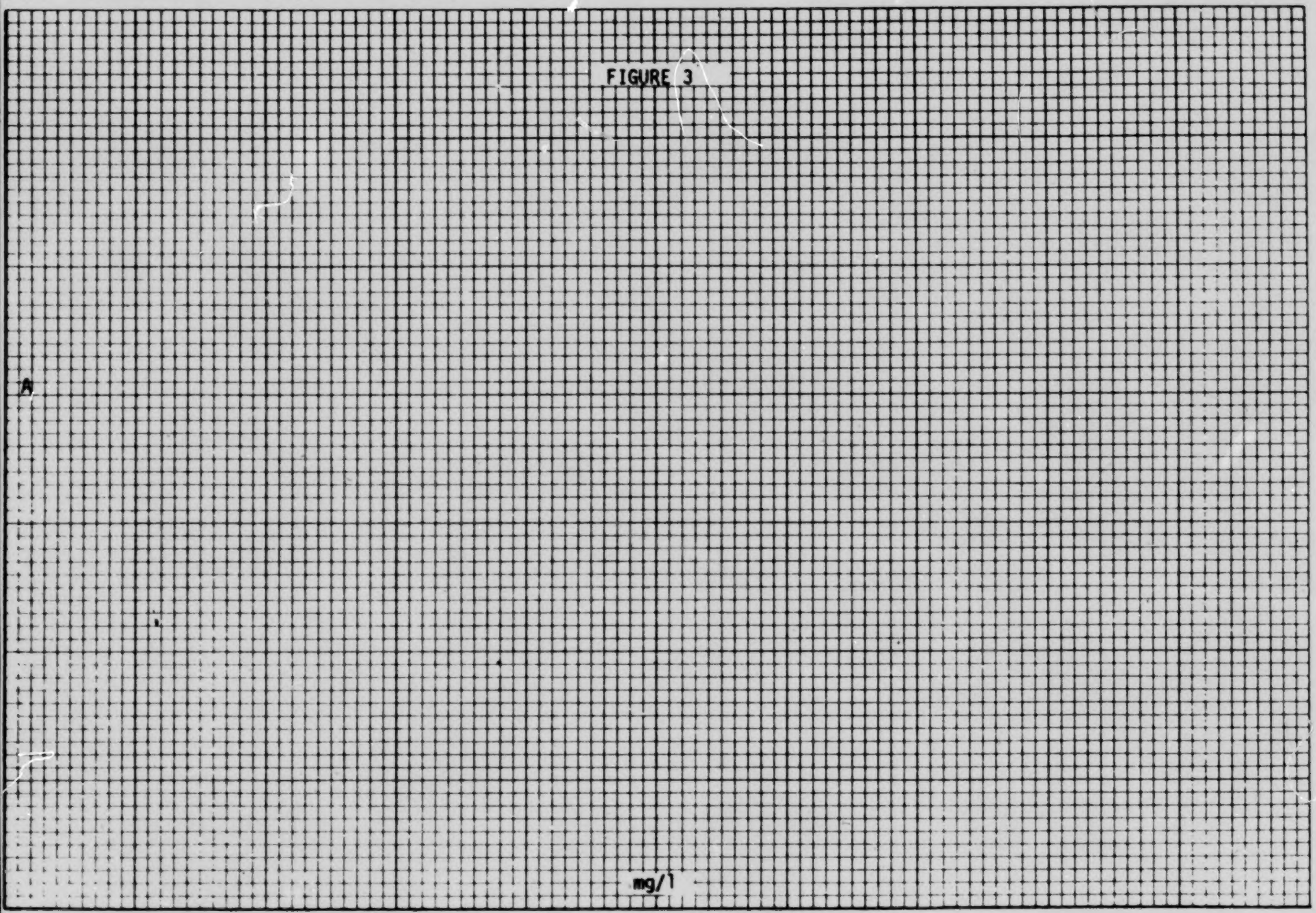
4. Determining the concentration of the chemical constituent in the sample.
    a. Locate 0.180 on the A axis.
        1. This was the absorbance of the sample
    b. Draw a horizontal line to the right side of the paper.
        1. It should now look like figure 10.
    c. Locate the intersection of this horizontal line and the sloping calibration graph.
    d. From this intersection, draw a vertical line down to the bottom of the paper.
        1. It should now look like figure 11.
    e. Note that the vertical line crosses the mg/l axis at 15.3
        1. Recall that on the mg/l axis, 2 of the small squares equal 1 mg/l.
        2. 15.3 mg/l is therefore the concentration of the chemical constituent being measured in the sample.
5. Sample dilution
    a. If it was necessary to dilute the sample, the value read from the mg/l axis must be multiplied by a dilution factor.
        1. The dilution may have been necessary so that the A value for the sample would not be greater than the A value obtained for the highest concentration standard; 0.590 in this set of example data.

2. The dilution factor is the ml. of sample taken for dilution, divided into the ml. to which it was diluted; e.g., if 10.0 ml. of the original sample were diluted to 1000 ml. (as in a volumetric flask) the dilution factor would be 1000/10, or 100/
3. In some determinations, you may prepare more than one dilution of the sample. Look at the mg/l axis of figure 1 and assume that three dilutions of the sample gave values of 2.2, 24.0, and 48.0 mg/l, before correcting for the dilution factor. It is common practice to use the 24.0 value, since it lies nearest the middle of the calibration graph.

FIGURE 1

FIGURE 2

FIGURE 3



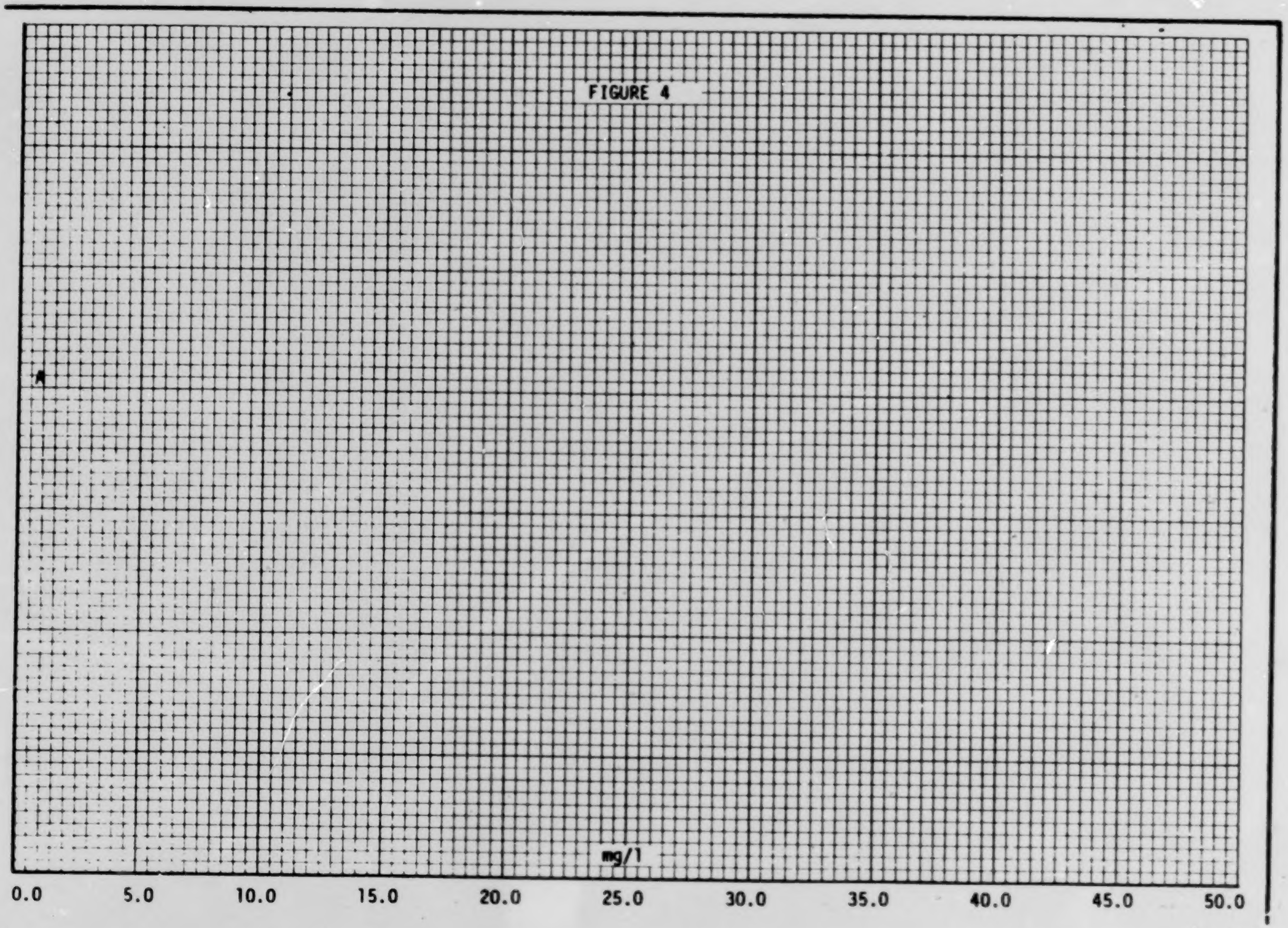


FIGURE 4

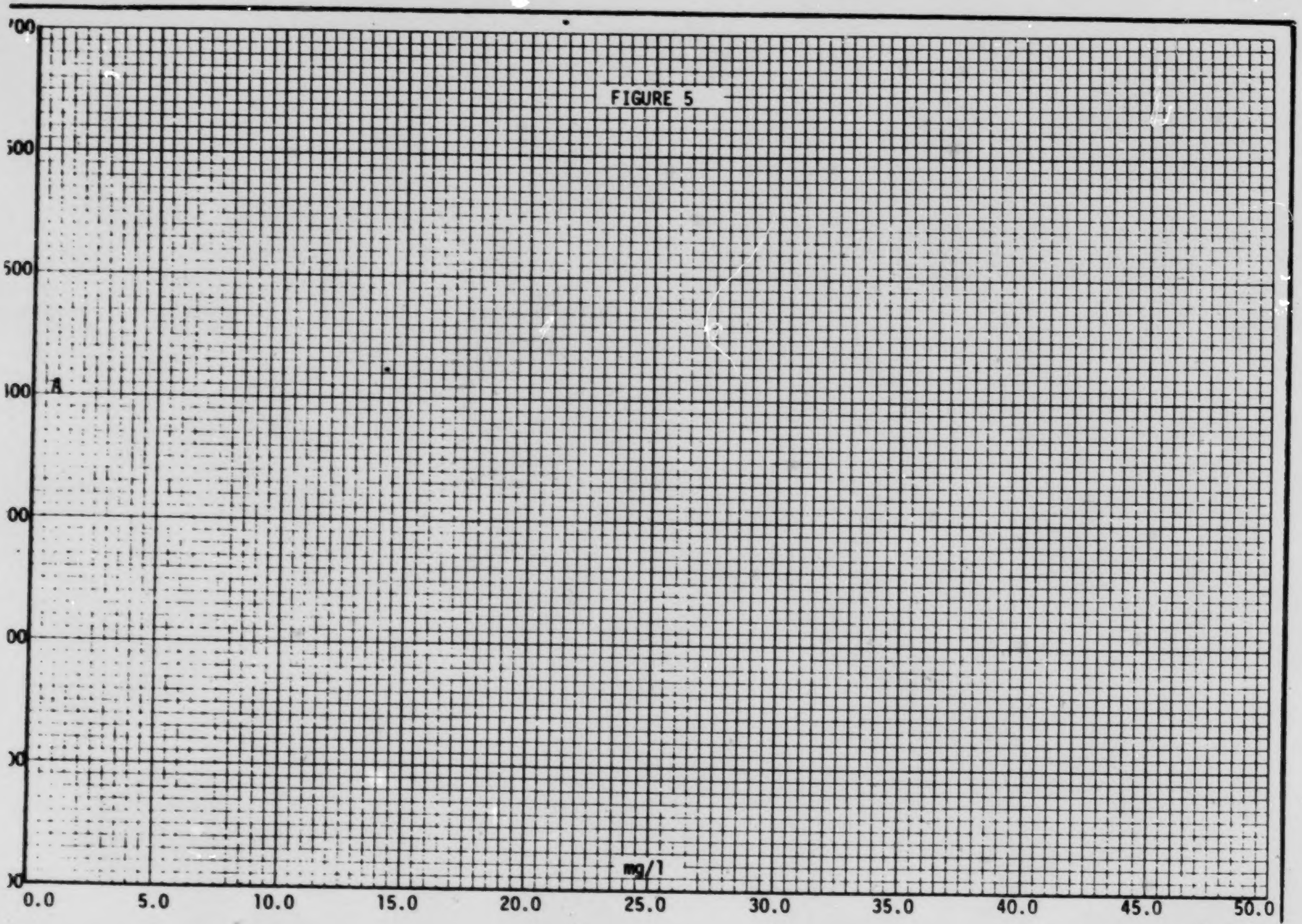
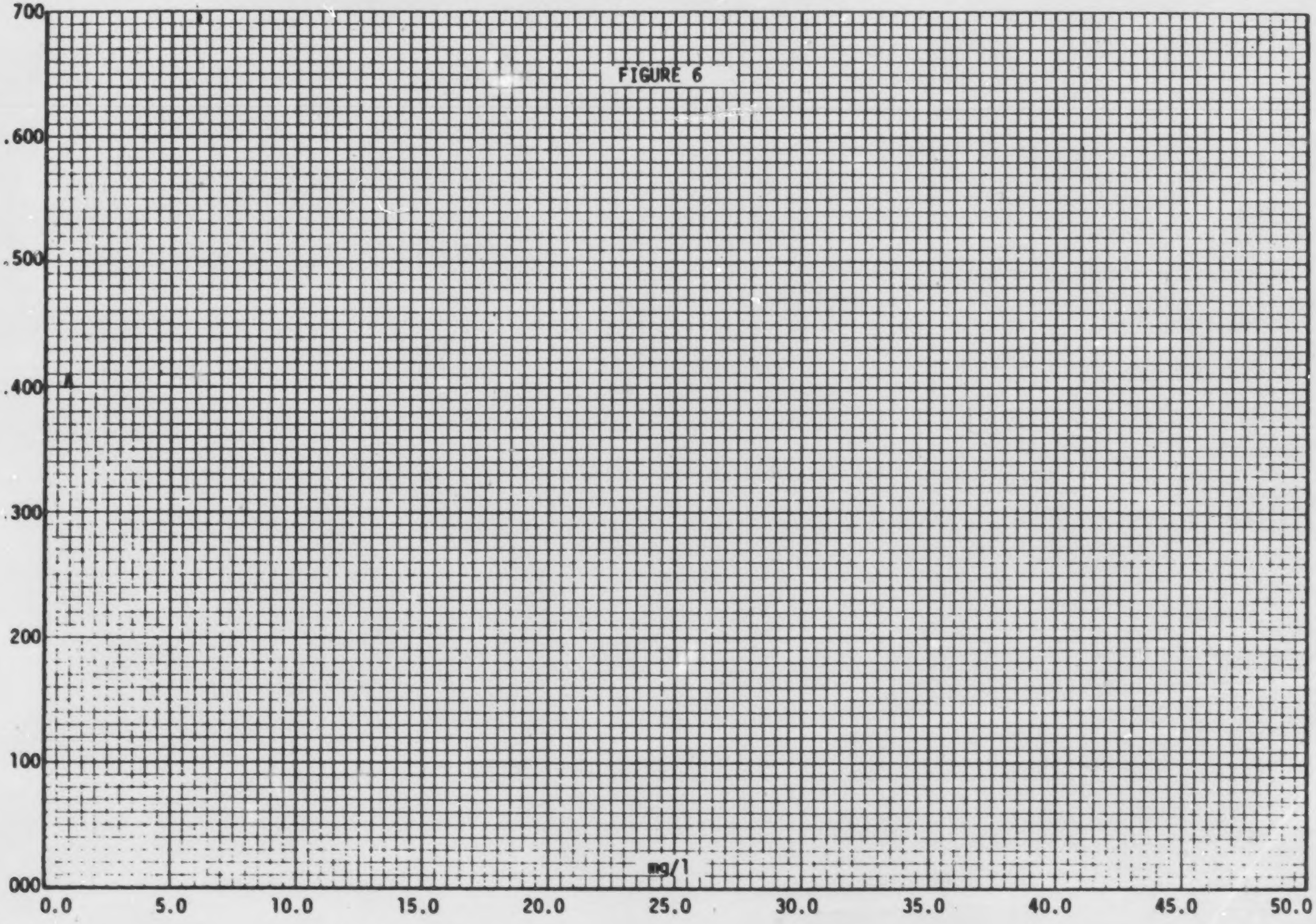


FIGURE 5
A
mg/1
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0

FIGURE 6


700
.600
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000
0.0
5.0
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15.0
20.0
25.0
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40.0
45.0
50.0
mg/l
A

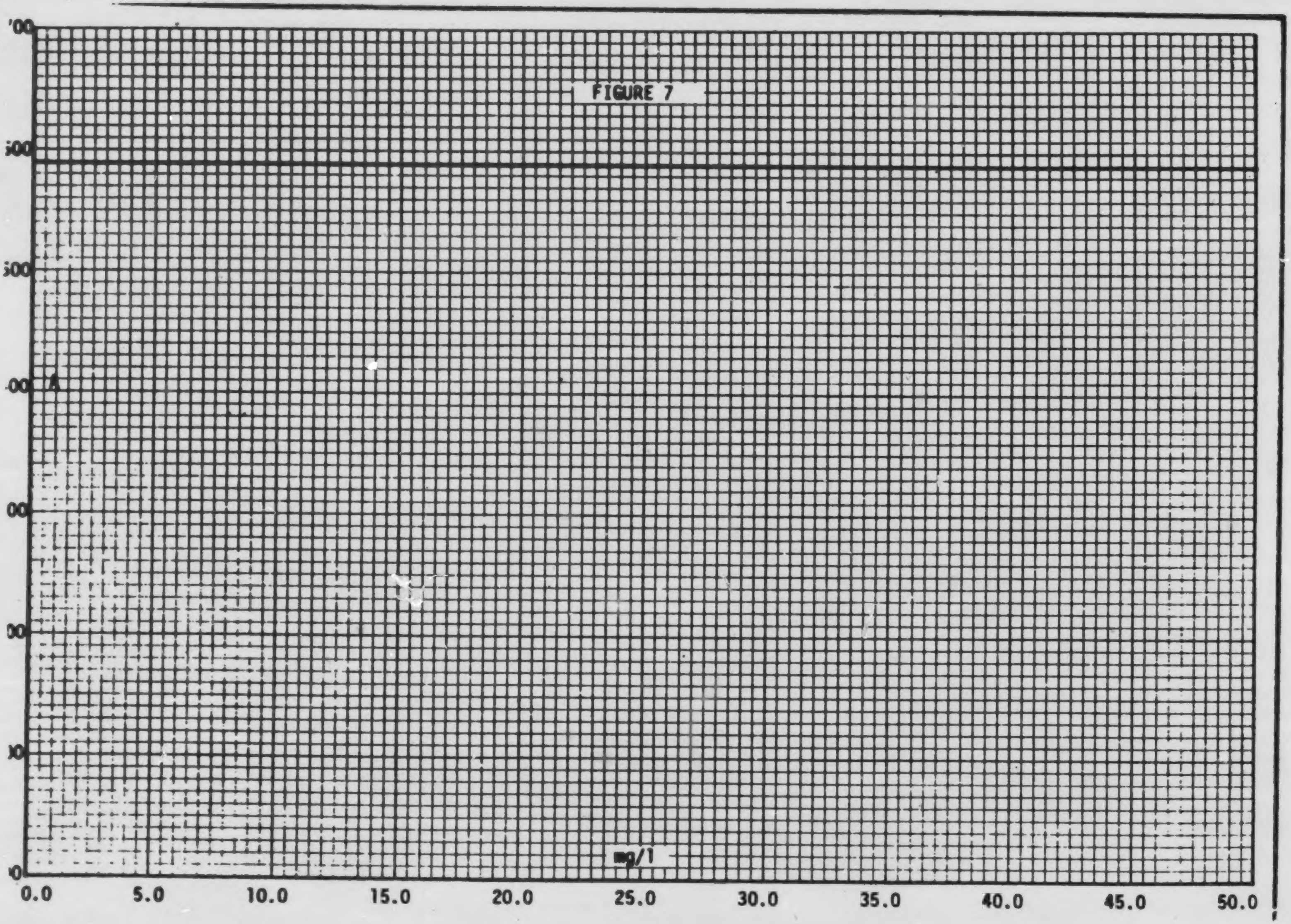


FIGURE 7

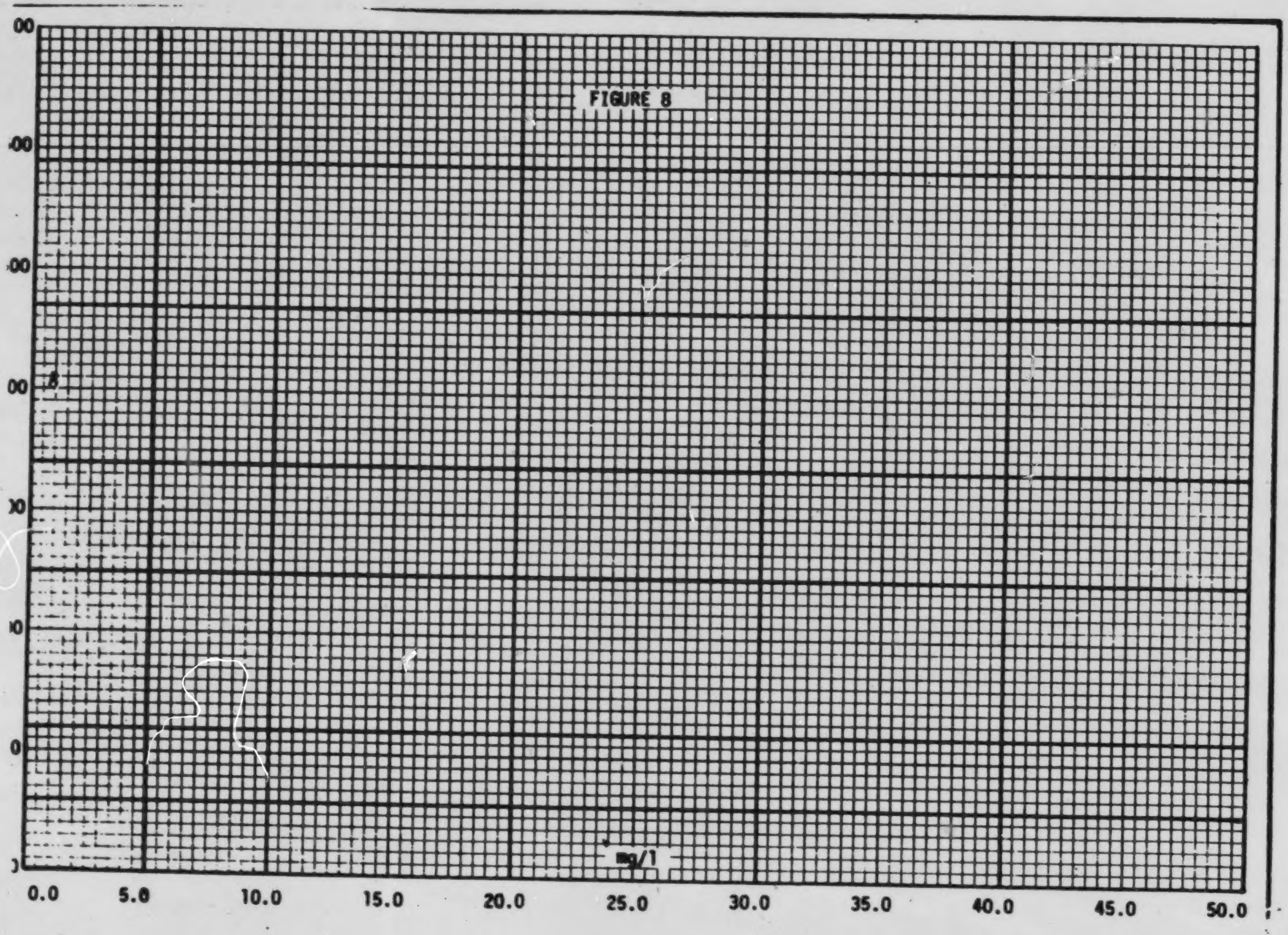


FIGURE 8

FIGURE 9

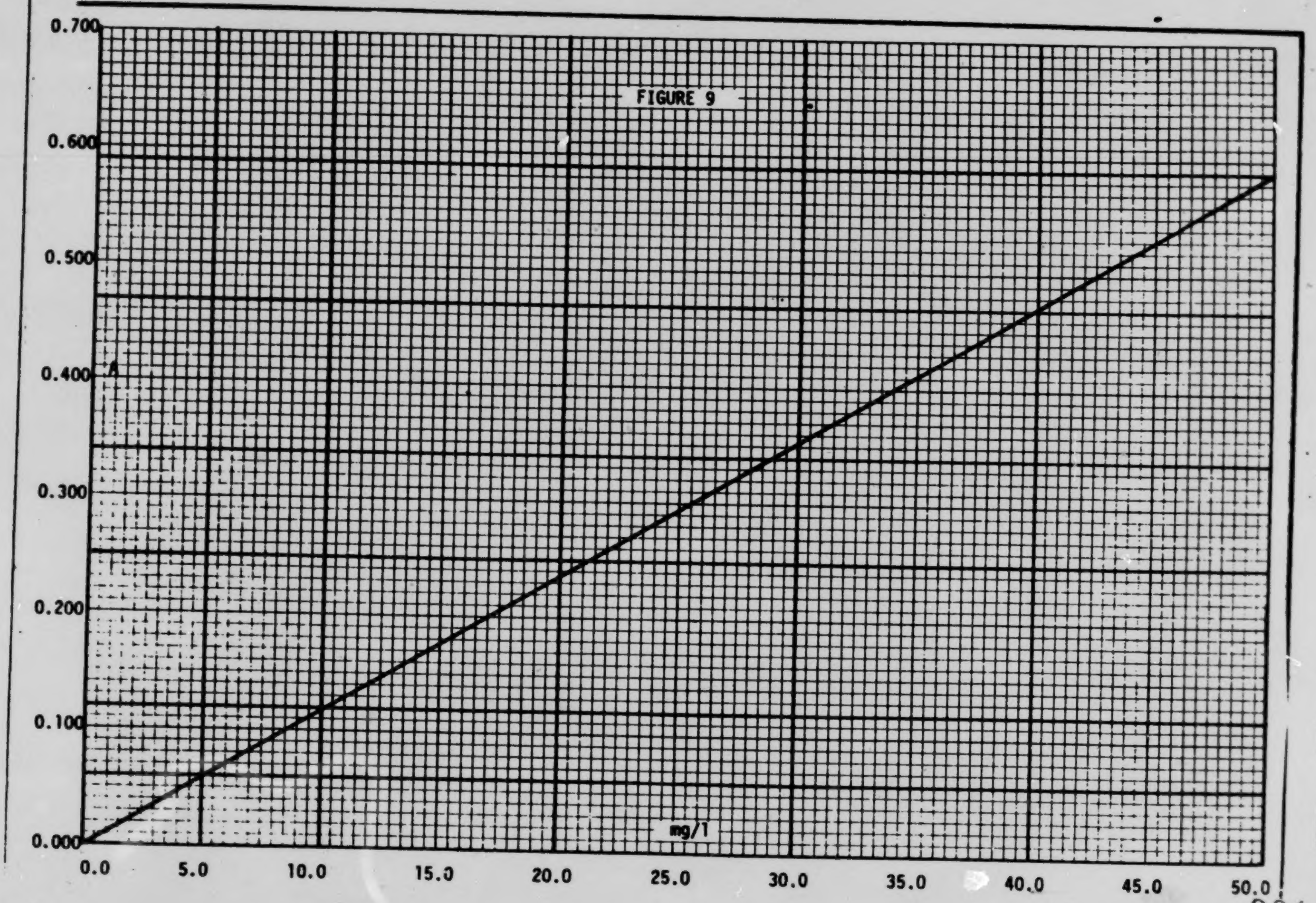
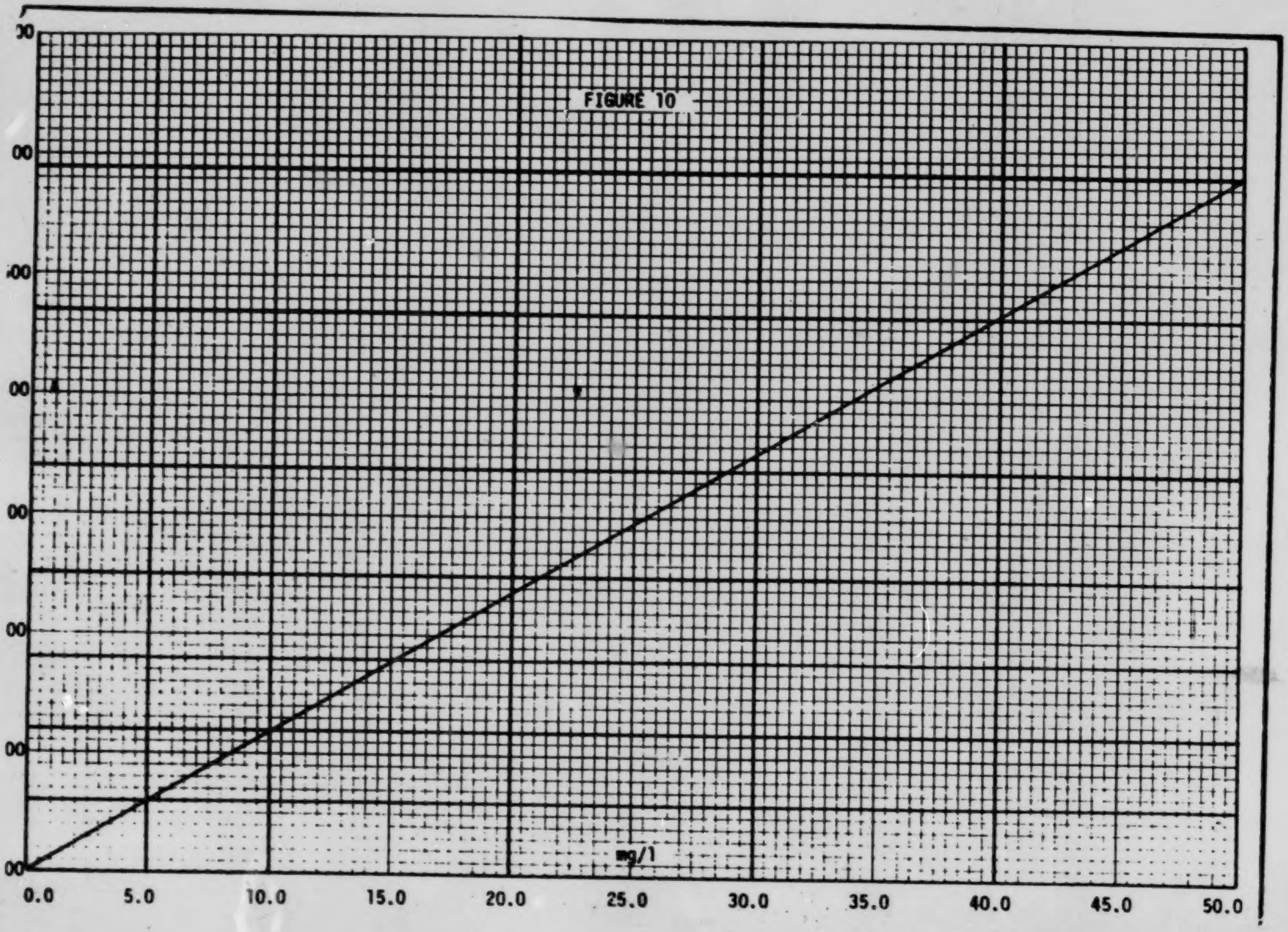
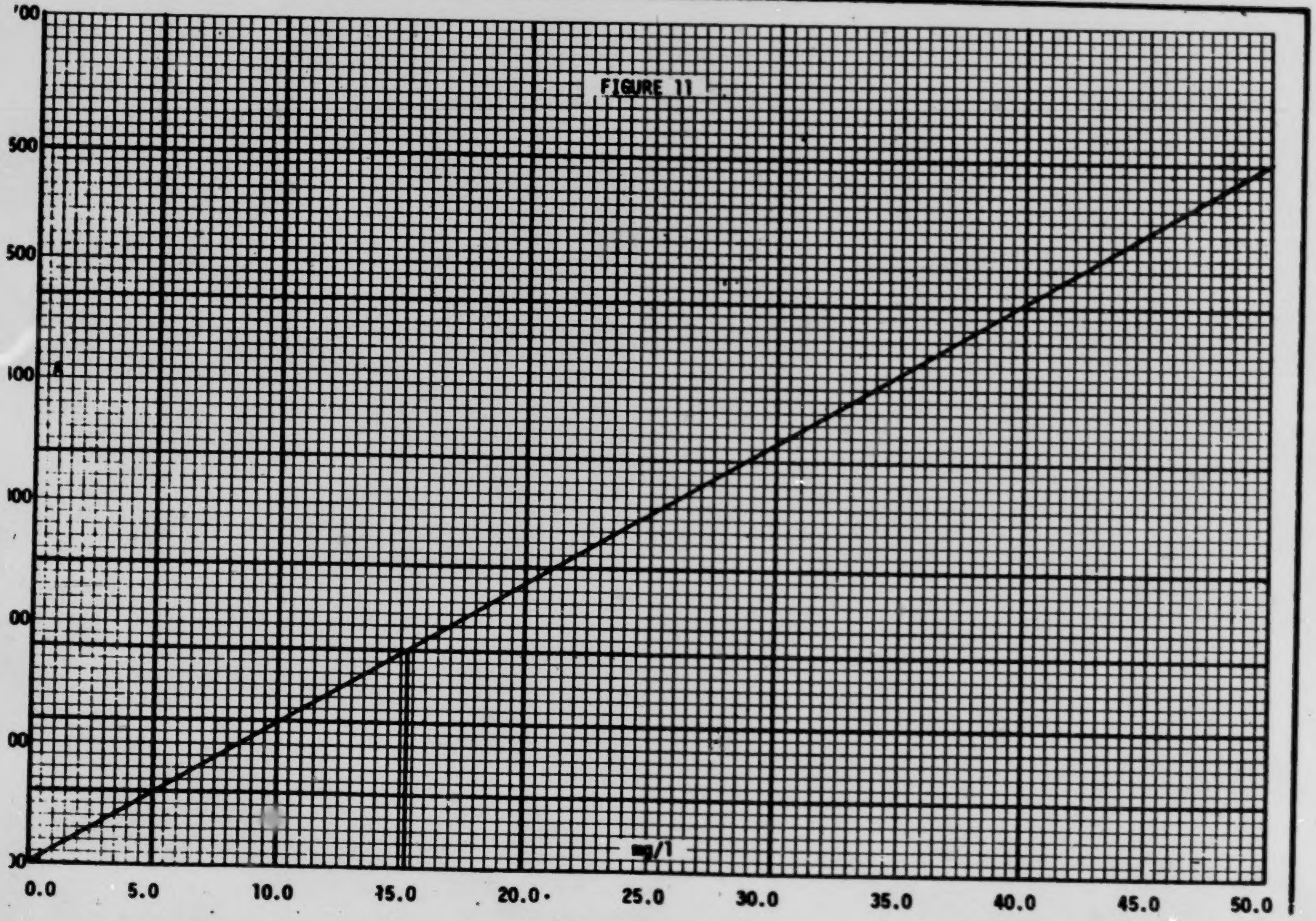

0.700
0.600
0.500
0.400
A
0.300
0.200
0.100
0.000
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
mg/l

FIGURE 10



FIGURE 11
'00
500
500
100
100
00
00
)0
A
mg/1
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0

Module No:	**Module Title:** Basic Laboratory Skills
Approx. Time: 1 hour	**Submodule Title:** Chemistry Skills
	Topic: Lab Supplies and Chemicals

Objectives:

Upon completion of this module, the participant should be able to:

1. Demonstrate the use of lab supply and chemical catalog in procuring lab supplies and chemicals.

Instructional Aids:

Catalogs Chemical and Supply

Instructional Approach:

Lab
Lecture

References:

None

Class Assignments:

Participate in laboratory practice session

Module No:	Topic: Lab Supplies and Chemicals

Instructor Notes:	Instructor Outline:
	1. a. Discuss lab and chemical supply catalogs. Grade of glassware, chemicals and equipment. Discuss shelf life and quantities to be ordered. b. Given a list of chemicals and apparatus have participant make up an order.

Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
Chemistry Skills

Approx. Time:
30 Min.

Topic:
Standard References

Objectives:

Upon completion of this module, the participant should be able to:

1. List the standard references approved by the Environmental Protection Agency.

Instructional Aids:

All Standard References

Instructional Approach:

Lecture

References:

Federal Regulations, Vol. 28, No. 199, pt2, Oct. 16, 1973

Class Assignments:

None

Module No:	Topic: Standard References

Instructor Notes:	Instructor Outline:
	List the standard references used in water and wastewater labs. Compare the formats of the references. Discuss the use of non-standard methods along with the value of standard methods.

Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
Microbiology Skills

Approx. Time:
1/3 hour

Topic:
Laboratory Cleanliness

Objectives:

Upon completion of this module, the participant should be able to:

1. State the proper method of cleaning a laboratory.
2. Identify the proper schedule and reason for laboratory cleaning.

Instructional Aids:

Handout: Laboratory Cleanliness

Instructional Approach:

Lecture
Discussion

References:

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition.

Class Assignments:

Read handout

Module No:	Topic: Laboratory Cleanliness

Instructor Notes:	Instructor Outline:
Handout: Laboratory Cleanliness	
1. Include discussion of: a. Disinfectants b. Use of vacuum cleaners c. Cleaning tools 1. Sponges 2. Towels 3. Scrubbers d. Cleaning and preserving stainless steel with mineral oil	1. Discuss methods of cleaning a laboratory used for microbiological analysis.
2. Include discussion of: a. Daily wipedowns b. Weekly wipedowns c. Major cleaning days d. Garbage cleanup	2. Discuss cleaning schedules and rational behind the schedules.

LABORATORY CLEANLINESS

A. Types of disinfectants

  1. 70% Ethanol
  2. Phenols i.e. O-Syl
  3. Quaterniary ammonium compounds
  4. Halogen compounds
  5. Activated sialdehyde i.e. cidex

B. Use of disinfectants

  1. Weekly
     a. Wipe down all shelves removing all glassware and books
     b. Wipe down all incubators, inside and outside
     c. Wipe out inside of autoclave.
  2. Daily
     a. Wipe down tops of all counters, large pieces of equipment
  3. Immediately before testing disinfect work area
  4. Immediately disinfect spills

C. Sources of Contamination

  1. Dirt around lab
  2. Spilled samples or cultures
  3. Un-autoclaved bacterial garbage
  4. Chemical contamination from use of glassware for both Chemistry testing and Bacterial testing.

Module No:	**Module Title:** Basic Laboratory Skills
	Submodule Title: Microbiology Skills
Approx. Time: 2/3 hour	**Topic:** Equipment Packaging

Objectives:

Upon completion of this module, the participant should be able to:

1. Demonstrate the ability to determine how a piece of equipment must be packaged and labeled for sterilization.
2. Identify reason for packaging equipment.

Instructional Aids:

Handout: Equipment Packaging
Laboratory practice

Instructional Approach:

Lecture
Discussion
Demonstration and supervised laboratory practice

References:

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition.

Class Assignments:

Read handout
Complete laboratory assignment

Module No:	Topic: Equipment Packaging

Instructor Notes:	Instructor Outline:
Handout: Equipment Packaging	
1. Include explanation of: a. Why brown (non-bleeding) Kraft paper is used. b. When aluminum foil is used. c. What a bacterial barrier represents. 1. In liquid 2. In air	1. Discuss and demonstrate the choice and method of equipment packaging including packaging for steam and hot air sterilization.
	2. Discuss the purpose of the packaging.
	3. Have participant practice by packaging an article for sterilization.

EQUIPMENT PACKAGING

I. Preparation
  A. All glassware and filter funnels must be thoroughly washed in non-toxic detergent
    1. i.e. Alconox
    2. Removes bacterial scum from glassware
  B. Rinse 6 - 12 times in hot tap water
    1. Removes detergent residue
    2. Residue is harmful to bacteria
  C. Final rinse 1 - 3 times in distilled water
    1. Removes mineral residue from tap water
    2. Prevents water spotting
  D. Air Dry
    1. Any spot indicates dirt
    2. Rewash before using

II. Packaging
  A. Reasons for packaging
    1. Creates a bacteria barrier
    2. Allows for storage of sterile equipment
  B. Proper labeling
    1. Define contents
    2. Date to aid in equipment rotation

C. Proper package
    1. Brown Kraft paper
    2. Aluminum foil
    3. Glycine bags
    4. Misc. containers appropriate to sterilization method

III. Sterilization of equipment - 2 Acceptable Methods

A. Autoclave
    1. All rubber, metal and glassware and some plastics
    2. Normal cycle 15 min. 15 121° C.
    3. Exhaust rapidly

B. Hot air sterilizing oven
    1. Dry glassware and metal objects only
    2. Normal cycle 1 hr. at 170° C.
    3. Allow to cool before use
    4. Package pipets in metal containers
    5. Package other equipment with aluminum foil

Module No:	**Module Title:** Basic Laboratory Skills
	Submodule Title: Microbiology Skills
Approx. Time: 2/3 hour	**Topic:** Media and Reagent Preparation

Objectives:

Upon completion of this module, the participant should be able to:

1. Demonstrate the ability to prepare and dispense microbiologicals.
2. State precautions which must be taken to insure accuracy.

Instructional Aids:

Laboratory Practice

Instructional Approach:

Lecture
Discussion
Demonstration and laboratory practice

References:

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition.

Class Assignments:

Complete laboratory assignment

Module No:	Topic: Media and Reagent Preparation
Instructor Notes:	**Instructor Outline:**
1. Emphasize: a. Complete dissolution b. Proper heating c. Accurate dispensing d. Careful sterilization	1. Discuss and demonstrate the proper procedure for preparation and dispensing microbiologicals.
2. Include: a. Measurement b. Overheating c. Under heating d. Sterilization	2. Describe areas of common error and discuss precautionary measures.

Module No:	**Module Title:** Basic Laboratory Skills
	Submodule Title: Microbiology Skills
Approx. Time: 1/2 hour	**Topic:** Autoclaves & Steilizing Ovens

Objectives:

Upon completion of this module, the participant should be able to:

1. State precautions applicable to the use and care of all autoclaves and sterilizing ovens.
2. Demonstrate the proper loading, cycling, and removal of sterile equipment from an autoclave and sterilizing oven.
3. Differentiate between items sterilized in an autoclave and those sterilized in a sterilizing oven.

Instructional Aids:

Handout
Laboratory Practice

Instructional Approach:

Lecture
Discussion

References:

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition.

Class Assignments:

Read handout
Complete laboratory assignment

Module No:

Topic: Autoclaves and Sterilizing Ovens

Instructor Notes:	**Instructor Outline:**
Handout: Autoclaves and Sterilizing Ovens 1. Emphasize safety	1. Discuss the precautions which must be taken when operating: a. An autoclave b. Sterilizing oven
	2. Describe care and cleaning procedures for autoclaves and sterilizing ovens.
	3. Describe and demonstrate the proper loading and use of autoclaves and sterilizing ovens.
	4. Describe the type of equipment which is sterilized by each of the methods discussed.

AUTOCLAVES AND STERILIZING OVENS

A. Autoclave

1. Before using read and follow manufacturers installation use and maintenance instructions and safety precautions.
2. Normal sterilization = 15 psi yielding 121° C. for 15 min.
3. Use to sterilize liquids and non-heat sensitive equipment
   a. Most plastics are not autoclavable and sterilized by manufacturer.
   b. Sterilized media and reagents must be removed from autoclave as soon as possible after autoclave is opened.
   c. Glassware may be sterilized in autoclave but must be allowed to dry before removing from autoclave.

B. Hot air Sterilizing Oven

1. Before using read and follow manufacturers installation, use, and maintenance instructions and safety precautions.
2. Normal Sterilization = 1 hour at 180° C.
3. Use to sterilize glass and metal only
   a. Rubber and plastics will melt.
   b. Liquids will evaporate and grow media components will be destroyed

Module No:	**Module Title:** Basic Laboratory Skills
Approx. Time: 1½ hour	**Submodule Title:** Microbiology Skills
	Topic: Microscopes

Objectives:

Upon completion of this module, the participant should be able to:

1. State precautions applicable to the care and use of microscopes.
2. Identify and use a microscope to focus a speciman given the microscope, the speciman and appropriate reference materials.

Instructional Aids:

Handout: Microscopes
Transparancy on Microscopes
Laboratory practice

Instructional Approach:

Lecture
Discussion

References:

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition
2. Benson, Harold, Microbiological Applications, Wm. C. Brown Inc., Dubuque, Iowa, 1967.

Class Assignments:

Read handout
Complete laboratory assignment

Module No:	Topic: Microscopes

Instructor Notes:	Instructor Outline:
Handout: Microscopes Microscope Transparancy	
1. Include: a. Handling b. Storage c. Cleaning	1. Discuss and demonstrate proper care of a microscope.
	2. Discuss and demonstrate the proper method of focusing and examining a speciman a. Using a compound microscope b. Using a dissecting microscope
	3. Differentiate between a compound microscope and a dissecting microscope by examining the components of each.

MICROSCOPES

Proper Care

Regardless of whether a microscope is a compound or dissecting microscope, they are essentially similar. All contain a controlled light source and a geared mechanism for adjusting the distance between the object and the lenses. When carrying a microscope, always use both hands. Grap the arm with your right hand and use your left hand to grip the base. Carry the scope directly in front of you. If it is allowed to swing at your side, the microscope can easily be damaged by a collision with a door frame or piece of furniture.

Cleaning the lenses must be done with great care as they can be easily scratched and any such mar on the highly polished surface will impare its efficiency. Dust on the eye pieces or objectives should only be removed with lens tissue, a camel's hair brush. Dust inside the eyepiece can be gently blown out. Use lens cleaner (an oil solvent) sparingly on a lens tissue to remove oil from eyelashes on the eyepieces or immersion oil from the oil immersion lens. Quickly remove any excess lens cleaner with a dry lens tissue.

When cleaning the eyepiece be sure and cover the open end with a tissue to keep out any dust.

After use, care must be taken to (1) remove the speciman from the stage, (2) Remove all oil or other debris from stage and lens, (3) Return lenses to low power position, (4) Secure any electrical cords around scope, (5) Re-center stage (If mechanical), (6) Replace dust cover and store in designated cupboard.

Focusing

In focusing the dissecting microscope, simply place the speciman on the stage and adjust the distance with the focusing knob until the speciman is clearly seen.

Focusing a compound microscope is a bit more difficult since you have a series of objectives to work with. To focus for low power (10 x) examination, (1) Raise the condenser to top position and close down diaphram to lower the light level to best see the speciman, (2) Swing the 16 mm. (10 x) lens into position (3) Lower the lens to just above the speciman (B & L) or to stop position (A.O.) and focus by raising objective with fine adjustment knob.

From the focused low power you can go directly to the high dry lens (43 x) with only minor adjustment using the fine knob to bring the speciman into focus.

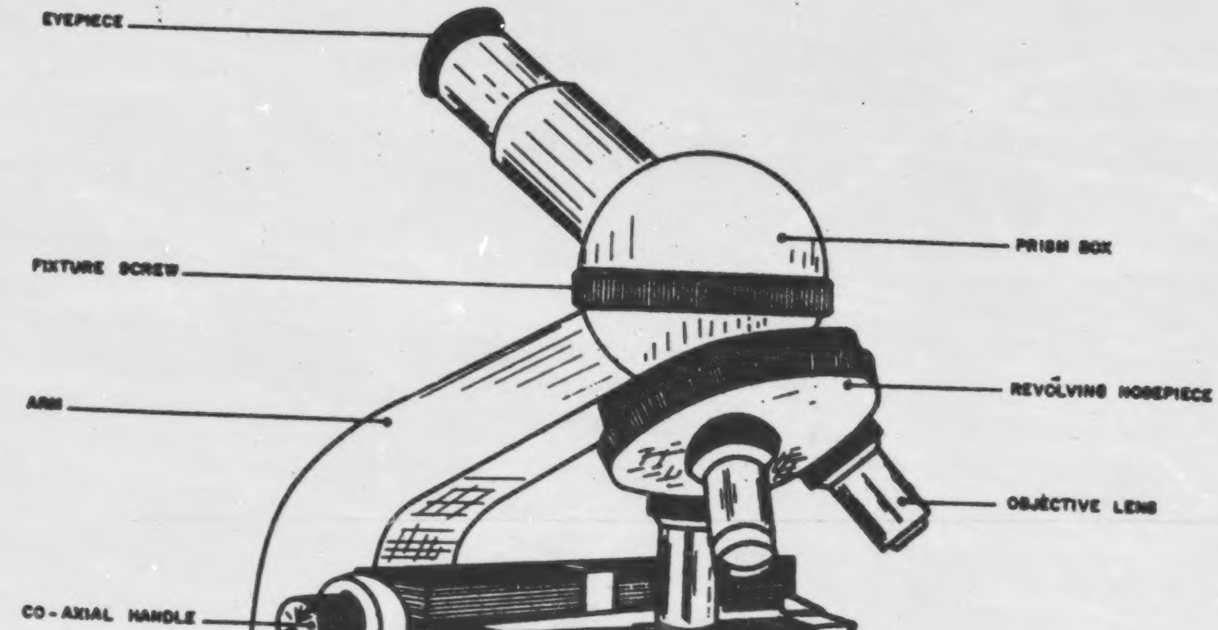
To move, however, to the oil immersion lens (100 x) a drop of immersion oil must be placed between the lens and the speciman. The lens is then lowered to make contact with the oil and then the fine adjustment knob is used to focus the speciman.

The low power lens is primarily used to scan the slide and the high-dry for focusing protozoa, algae and mold. The oil immersion lens is used directly for stained bacteria as the low power and high dry do not magnify sufficiently even for scanning.

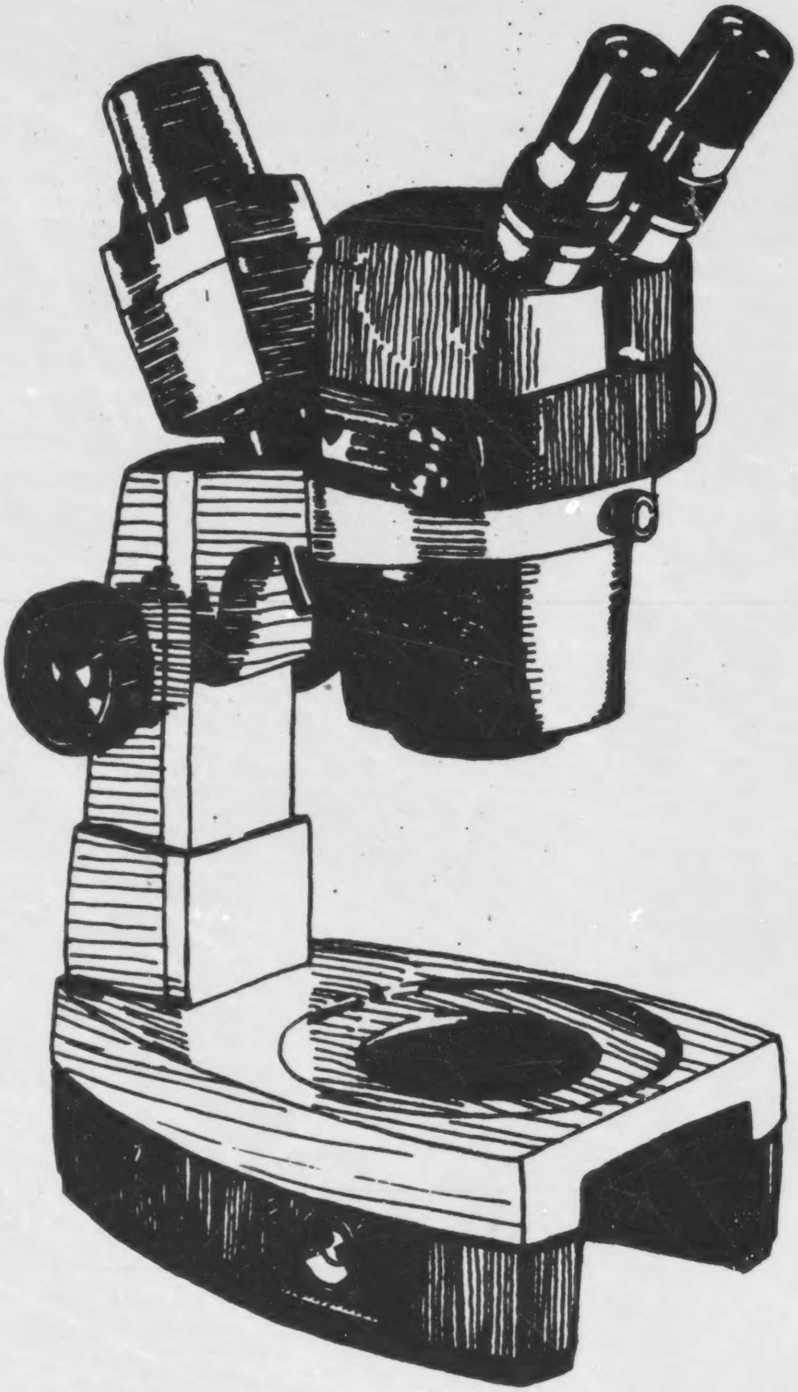
Structure

In order to best compare the differences in structures is to examine the following two diagrams:

PARTS OF THE MICROSCOPE


EYEPIECE
FIXTURE SCREW
ARM
CO-AXIAL HANDLE
FINE ADJUSTMENT
COARSE ADJUSTMENT
PRESET FOCUS LOCK
ILLUMINATOR BASE
PRISM BOX
REVOLVING NOSEPIECE
OBJECTIVE LENS
STAGE
CONDENSER
CONDENSER STOP
MIRROR
BASE

PARTS OF THE DISSECTING SCOPE



Module No:

Module Title:
Basic Laboratory Skills

Submodule Title:
Microbiology Skills

Approx. Time:
1 hour

Topic:
Aseptic Technique

Objectives:

Upon completion of this module, the participant should be able to:

1. Demonstrate aseptic technique in making transfers from bottles and other containers using pipets, loops, and needles and forceps.
2. Identify reasons for aseptic technique in making transfers.

Instructional Aids:

Laboratory Practice

Instructional Approach:

Lecture
Discussion
Demonstration and Supervised Laboratory Practice

References:

Standard Methods for the Examination of Water and Wastewater

Class Assignments:

Complete laboratory assignment

Module No:

Topic:
Aseptic Technique

Instructor Notes:	Instructor Outline:
1. Using: a. Pipets b. Loops c. Needles d. Forceps	1. Discuss and demonstrate the proper procedures for making aseptic transfers from: a. Dilution blanks to tubes b. Dilution blanks to filtering funnels c. Tubes to tubes d. Other containers using forceps
	2. Discuss necessity for aseptic technique.
	3. Describe problems which arise when aseptic technique to actual laboratory procedures.
4. Include: a. Sample collection b. Sample dilution c. Media transfers d. Culture transfers	4. Relate aseptic technique to actual laboratory procedures.
5. Include: a. Weighing dry chemicals and biologicals b. Use of dirty glassware c. Storing and measuring solutes (i.e. distilled water)	5. Explain how routine practice of aseptic technique where applicable leads to more awareness of contamination in other areas.

Module No:

Module Title:

Basic Laboratory Skills

Submodule Title:

Microbiology Skills

Approx. Time:

1/2 hour

Topic:

Microbiological Sample Collection

Objectives:

Upon completion of this module, the participant should be able to:

1. Properly prepare sample bottle and take a grab sample from:
    a. A spigot or tap
    b. An open body of water
2. Identify precautions which must be taken before, during and after sampling to protect sample and reasons for these precautions.

Instructional Aids:

Handout: Microbiological Sample Collection

Instructional Approach:

Lecture
Discussion

References:

Standard Methods for the Examination of Water and Wastewater

Class Assignments:

Read handout

Module No:	Topic: Microbiological Sample Collection

Instructor Notes:	Instructor Outline:
Handout: Microbiological Sample Collection	1. Describe the proper method of preparing a sample bottle for the collection of microbiological samples from: a. Chlorinated sources b. Unchlorinated sources 2. Describe areas where error is likely to occur and the effect on the final result. 3. Describe the proper procedure for obtaining a grab sample from a spigot or tap and an open body of water. 4. Discuss sample protection and preservation.

MICROBIOLOGICAL SAMPLE COLLECTION

I. Preparation of Sampling Equipment

A. Sample bottles must be:

1. At least 100 ml capacity with a large neck opening.
2. Thoroughly cleaned with detergent, rinsed 6 times in hot tap water, rinsed finally in distilled deionized water, then air drie
3. Free from spots, scum, chips, cracks, excessive scratches and othe damage on which bacteria may lodge.
4. Closed with preferably an all glass ground cap closure (but screw caps can be used providing liners are free from contamination and provide a non-leaking seal.
5. Sterilized in an autoclave at 121° C. for 15 min. with Kraft paper or tin foil hood covering caps and necks of bottles and slip of paper between bottleneck and glass stopper to prevent glass stoppe from sticking.

B. Bottles intended for use in collection of chlorinated samples must hav a 10% sodium thiosulfate solution added at the rate of 0.1 ml for each 4 oz. bottle prior to sterilization and sterilized in bottle.

C. Labels must be:

1. Clean and unused
2. Attached to bottle by a means not affected by water (i.e. string or wire.)

D. Label markers must be:

1. Permanent type not affected by water
2. Able to mark on label

E. Sampling devices must be in working condition and properly maintained.

F. Germicide must be available to clean up spills but must not come in contact with sample or any equipment touched by sample.

G. Rubber gloves must fit and not be punctured.

H. Ice chest for transporting sample must be:

1. Sufficient size to accommodate all samples
2. Undamaged with tight cover so cold temperature can be maintained inside.
3. Filled with enough ice to quickly chill sample but little or no free water.

I. Refrigerator must be set at 2 - 10° C. and used if samples are not examined upon immediate return to lab.

II. Collection of Sample

A. To take sample from spigot or tap:

1. Find spigot with direct main connection
2. Put on rubber gloves
3. Flush spigot at full flow for 2 - 3 min. to clear service line
4. If right handed, hold sample bottle near bottom with right hand and remove closure and paper hood with left hand (reverse if left handed). DO NOT LAY CLOSURE DOWN. Hold in such a way to protect closure and bottle from contamination.
5. Allow slip of paper between closure and bottle neck to fall to floor.
6. Thrust bottle into flowing water and allow bottle to fill about 3/4ths full. DO NOT RINSE, especially if bottle contains sodium thiosulfate to neutralize chlorine in sample.

7. Carefully replace closure and hood and secure.
8. Label bottle and place on ice in ice chest for transportation to laboratory.

B. To sample river, stream, lake, etc.

1. Put on rubber gloves.
2. If right handed, hold sample bottle near bottom with right hand and remove closure and paper hood with left hand (reverse if left handed). DO NOT LAY CLOSURE DOWN. Hold in such a way to protect closure and bottle from contamination.
3. Allow paper strip between and bottle to fall to ground.
4. To fill sample bottle
   a. Turn bottle neck opening down and plunge below surface of water quickly to prevent dechlorinating agent from running out.
   b. Turn upward to face bottle opening into current to avoid contamination of water flowing into bottle with samplers hand.
   c. Allow to fill to about 3/4 full. DO NOT OVERFILL especially if bottle contains a dechlorinating agent.
   d. Lift quickly out of water and replace closure and hood.
5. Label bottle and place on ice chest for transportation to laboratory.

II. Common Errors and Affect on Results

A. No dechlorinating agent in bottle. Chlorine activity continues until sample tested so bacteria continue to die and coliform determination gives count which is lower than actual.

B. Sample not chilled when taken. Bacteria continue to multiply, so coliform determination gives count which is higher than actual.

C. Bottle or closure contaminated. Extra bacteria introduced, so coliform determination may give count which is higher than actual.

D. Sample not examined within 6 hrs. of collection. Bacteria will begin to die, so coliform determination will give counts which are lower than actual.

Module No:

Module Title:

Basic Laboratory Skills

Submodule Title:

Microbiology Skills

Approx. Time:

1/2 hour

Topic:

Microbiological Dilution Techniques

Objectives:

Upon completion of this module, the participant should be able to:

1. Demonstrate the ability to aseptically prepare a serial dilution of a sample, given all necessary equipment and reference material.
2. Identify precautions which must be taken to prevent contamination at each point of the dilution series.

Instructional Aids:

Handout: Microbiological Dilution Techniques

Laboratory Practice

Instructional Approach:

Lecture
Discussion
Demonstration and laboratory practice

References:

Standard Methods for the Examination of Water and Wastewater

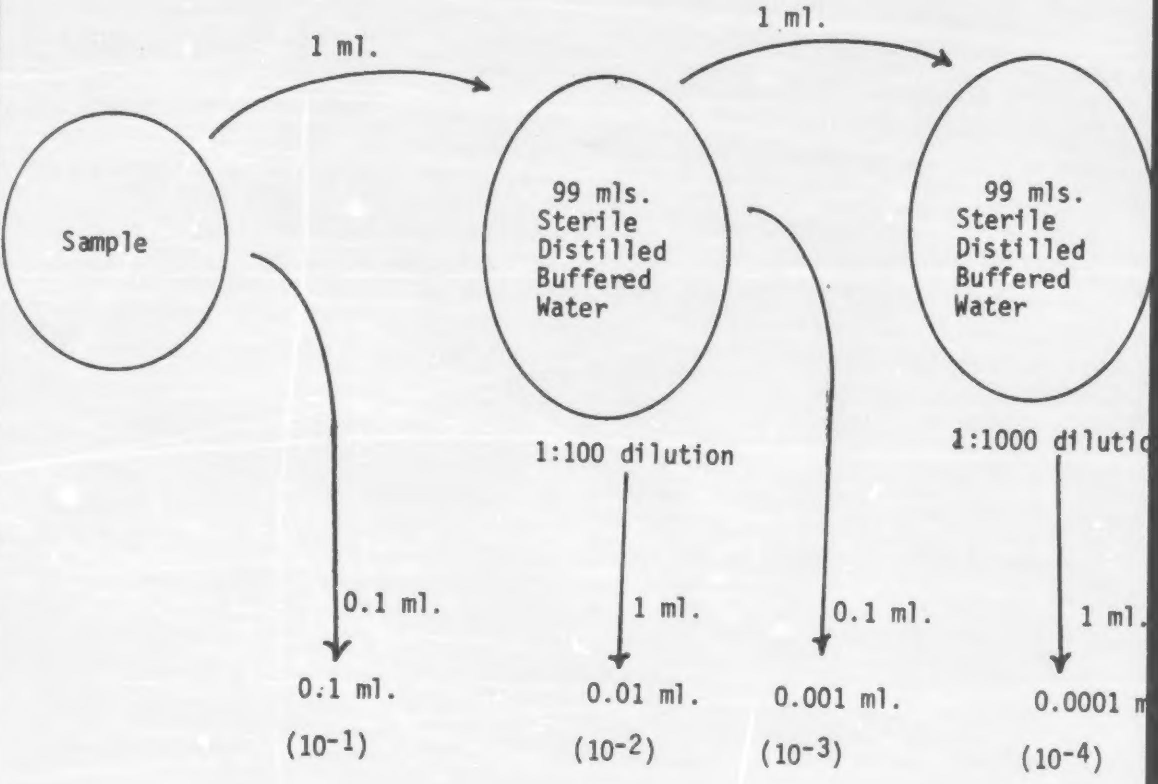
Class Assignments:

Complete laboratory assignment
Read handout

Module No:	Topic: Microbiological Dilution Techniques

Instructor Notes:	Instructor Outline:
Handout: Microbiological Dilution Techniques	
1. Emphasize: a. Aseptic technique b. Precision and accuracy	1. Discuss and demonstrate the proper technique for aseptically preparing a serial dilution for microbiological analysis.
	2. Discuss the equipment needed for preparing serial dilutions.
	3. Discuss areas where error is most likely and the effect of errors on results.

MICROBIOLOGICAL SAMPLE DILUTION (Serial Type Dilution)


1 ml.
1 ml.
Sample
99 mls. Sterile Distilled Buffered Water
99 mls. Sterile Distilled Buffered Water
1:100 dilution
1:1000 dilutic
0.1 ml.
1 ml.
0.1 ml.
1 ml.
0.1 ml.
0.01 ml.
0.001 ml.
0.0001 m
(10^{-1})
(10^{-2})
(10^{-3})
(10^{-4})

A. Use Aseptic Technique throughout Procedure

B. Place 0.1 ml sample into culture tube for 0.1 ml dilution

C. For 0.01 ml sample volume

  1. Place 1 ml sample into a 99 ml dilution blank
  2. Shake vigorously 25 times in an arc of 12"
  3. 1 ml of this 1:100 dilution represents 0.01 ml of original sample

D. For 0.001 ml sample volume deliver 0.1 ml from 1:100 dilution into the culture tube.

E. For 0.0001 ml sample volume

1. Place 1 ml of the 1:100 dilution into a fresh 99 ml dilution blank.
2. Shake vigorously 25 times in an arc of 12"
3. 1 ml of this 1:10,000 dilution represents 0.0001 ml original sample volume.

F. For 0.00001 ml sample volume deliver 0.1 ml from the 1:10,000 dilution into the culture tube.

III. Precautions

A. All volume measurement must be accurate

B. Any measurement error will be compounded in later steps

C. Transfer sample volumes aseptically because any contamination will be carried through entire process.

Module No:	Module Title: Basic Lab Skills
Approx. Time: 1 hour	Submodule Title: General Skills EVALUATION - Part A

Objectives:

Upon completion of this module, the participant should be able to correctly answer 75% of the following evaluation questions.

Evaluation Questions

Answer the following questions by choosing the best answer or filling in the blanks.

1. Goggles are worn to

_____a. Protect the eyes

_____b. Protect the hands

_____c. Protect the lungs

_____d. Protect the feet

2. When diluting an acid with water

_____a. Always add the water to the acid

_____b. Mix alternately in a third beaker

_____c. Always add the acid to the water

_____d. Heat on a not plate

3. Broken glassware

_____a. Can be used if you are careful

_____b. Should be immediately disposed of in the proper waste can.

_____c. Wrapped with electrical tape before using

_____d. Handled with tongs or asbestos gloves

4. Laboratory notebook entries should be:

_____a. Recorded ball point pen

_____b. Recorded on the day the work was done

_____c. In cronological order

d. All of the above

5. Why must all containers be properly labeled?

_____a. To identify contents

_____b. To prevent accidents by misuse

_____c. Both a and b

_____d. Containers are not labeled

6. A general format for labeling reagent bottles includes:

a.________________________________

b.________________________________

c.________________________________

d.________________________________

7. A general format for labeling sample bottles includes:

_____a. Sample site, time and date

_____b. Sample site and samplers name only

_____c. Sample type, preservation method, sampler

_____d. Both a and c

8. What does CAP represent in sampling?

_____a. Cleanliness, accuracy, preservation

_____b. Caution - Animal preserve

_____c. Clean appropriate packaging

_____d. Careful and precise

9. Grab samples are

_____a. The same as composite samples

_____b. Taken at a specific time with no regard to flow rate

_____c. Representative of the sewage over a period of time

_____d. Of no value in water or wastewater evaluation

10. What 3 things does sample preservation retard?

a.____________________________

b.____________________________

c.____________________________

11. Identify:

a. An erlynmeyer flask

b. A 2 liter volumetric flask

c. A 500 ml beaker

d. A watch glass

e. A gooch crucible

12. Match

_____a. Water

_____b. Sulfuric acid

_____c. Calcium chloride

_____d. Sodium

_____e. Carbon

1. $CaCl_2$
2. Na
3. C
4. H_2O
5. H2SO4

13. As temperature increases, what happens to the volume of a liquid with respect to weight?

_____a. It decreases

_____b. Nothing

_____c. It increases

_____d. It turns to a solid

14. Hydroscopic chemicals

_____a. Pick up water from the atmosphere

_____b. Are always blue in color

_____c. Should be stored in a desicator

d. Both a and c are correct

15. What is the concentration in the following solutions:

    a. .1 gram CaCl dissolved in 1 liter of water gives a concentration of __________ mg/l CaCl.

    b. 10 grams of peptone dissolved in 100 grams of water gives a concentration of __________ percent peptone.

16. How much actual sample does 0.1 ml of the 1:100 dilution represent?

    _____a. .1 ml

    _____b. .01 ml

    _____c. .001 ml

    _____d. .0001 ml

17. What is an incubator used for?

    _____a. Drying chemicals

    _____b. Storing reagents

    _____c. Growing bacteria

    _____d. Preserving samples

    _____e. Killing bacteria

18. When installing an incubator, care must be taken to:

    _____a. Install in a vibration free area

    _____b. Install in direct sunlight

    _____c. Keep a pan of dry-rite in the bottom of the incubator

    _____d. All of the above

19. Weigh given object on triple beam balance (with range of 1 - 100 g).

20. Weigh given object on an analytical balance.

Module No:

Topic:
EVALUATION - Part A

Instructor Notes:

Answers:

1. a
2. c
3. b
4. d
5. c
6. a. Chemical name
   b. Symbol
   c. Concentration
   d. Date prepared
   e. Prepared by
7. d
8. a
9. b
10. a. Biological action
    b. Chemical change
    c. Volatility
11. a. Erlynmeyer flask
    b. Volumetric flask
    c. Beaker
    d. Watch glass
    e. Gooch crucible

Instructor Outline:

Upon completion of the General Skills module the instructor shall give the participant evaluation Part A to complete.

11. Instructor shall provide a variety of glassware from which the student must choose the correct items.

Page 6 of 6

Module No:	Topic: EVALUATION - Part A

Instructor Notes:	Instructor Outline:
12. a. 4	
b. 5	
c. 1	
d. 2	
e. 3	
13. c	
14. d	
15. a. 100	
b. 10	
16. c	
17. c	
18. a	
19. Result shall be ± 0.1 gram	19 & 20. Instructor shall provide weights
20. Result shall be ± 0.002 gram	

Module No:	Module Title: Basic Lab Skills
	Submodule Title: Chemistry Skills
Approx. Time: 1 hour	EVALUATION - Part B

Objectives:

Upon completion of this module the participant should be able to correctly answer 75% of the following evaluation questions.

Evaluation Questions

Choose the best answer

1. Accuracy is a measure of how close your answer is to the true answer.

_____a. True

_____b. False

2. Most forms of volumetric analysis include some form of color measurement.

_____a. True

_____b. False

3. Precision and accuracy mean the same thing.

_____a. True

_____b. False

4. All forms of volumetric analysis include a titration.

_____a. True

_____b. False

5. Rate in order of increasing accuracy.

_____a. 250 ml erlynmeyer

_____b. 250 ml volumetric flask

_____c. 250 ml graduated cylinder

6. Rate in order of increasing accuracy.

_____a. 10 ml mohr pipet

_____b. 10 ml volumetric pipet

_____c. 10 ml beaker

_____d. 10 ml graduated cylinder

7. Volumetric flasks are calibrated to contain

_____a. True

_____b. False

8. A 100 ml volumetric pipet and a 100 ml volumetric flask have the same accuracy and may be used interchangeable.

_____a. True

_____b. False

9. A graduated cylinder may be calibrated to deliver or to contain.

_____a. True

_____b. False

10. Given the normality and volume of a solution and the volume of a second neutralizing solution may be calculated.

_____a. True

_____b. False

11. Given the equivalent weight of a dissolved chemical and the volume that it is dissolved in, the normality of the solution can be calculated.

_____a. True

_____b. False

12. Adsorbance is inversely proportional transmittance.

_____a. True

_____b. False

13. The concentration of a colored solution is directly proportional to:

_____a. Its transmittance

_____b. Its absorbance

_____c. Both a and b

_____d. Neither a nor b

14. Adsorbance or transmittance of a sample is not affected by:

_____a. Turbidity

_____b. Diameter of sample tube

_____c. Amount of sample in tube

_____d. Type of sample tube

15. A standard curve is used to convert adsorbance or transmittance readings to concentration.

_____a. True

_____b. False

16. A standard curve may be made on any type of graph paper.

_____a. True

_____b. False

17. To obtain a straight line plot in colorametric analysis from a series of transmittance/concentration values __________ graph paper must be used.

_____a. Log-log

_____b. Semi-log

_____c. Linear

18. Indicate which of the following are EPA approved standard references.

_____a. Standard Methods, 14th Edition

_____b. Methods for chemical analysis of wastewater, EPA.

_____c. Simplified Methods for Wastewater Analysis, WPCF _____d. Simplified Methods for Water Analysis, AWWA.

_____e. ASTM Methods, Part 31

19. Changes in Standard Methods are official only when published in the federal register.

_____a. True

_____b. False

20. Order the following list of equipment using the model order form and the laboratory supply catalog provided by the instructor.

a. 400 sterile, disposable, glass, single wrapped, 10 ml pipets

b. 3-1000 ml class A, glass stoppered volumetric flasks

c. 24 milk dilution blanks with screw caps and 99 ml markings

d. 12-250 ml griffin beakers - heavy duty

e. 5 large tip mohr pipets

Supplier:

Quantity	Catalog Number	Description	Unit Price	Total Price

Module No:	Topic: EVALUATION - Part B
Instructor Notes:	Instructor Outline:

Answers:

1. a
2. b
3. b
4. a
5. a. 1
   b. 3
   c. 2
6. a. 3
   b. 4
   c. 1
   d. 2
7. a
8. b
9. a
10. a
11. b
12. b
13. b
14. c
15. a
16. a
17. b
18. a, b, & e

Module No:

Topic:
EVALUATION - Part B

Instructor Notes:	Instructor Outline:
20. The form shall be completed correctly with respect to: a. Quantity b. Catalog number c. Description d. Price e. Supplier name and address	20. The instructor shall provide the laboratory supp catalog of his choice providing all glassware listed is available from that supplier. The instructor shall also develop answer key from that catalog.

Page 1 of 4

Module No:	Module Title: Basic Lab Skills
Approx. Time: ½ hour	Submodule Title: Microbiology Skills
	EVALUATION - Part C

Objectives:

Upon completion of this module, the participant should be able to correctly answer 75% of the following evaluation questions:

Evaluation Questions

Answer the following questions by choosing the best answer.

1. What is the major purpose of a disinfectant?

_____a. To pick up dust with

_____b. To lower the number of viable organisms on a surface.

_____c. To wash glassware in

_____d. To

2. Kraft paper is used for packaging equipment for hot oven sterilization.

_____a. True

_____b. False

3. Only distilled water is used for preparation of microbiological growth media.

_____a. True

_____b. False

4. The balance used to weigh microbiological media and reagents must:

_____a. Have a 0.5 gram accuracy at a 150 gram load.

_____b. Have a 1 gram accuracy at a 200 gram load

_____c. Be an analytical balance

5. An autoclave has the capability of exploding while operating.

_____a. True

_____b. False

6. An autoclave may be loaded to a maximum of:

   _____a. 100% capacity

   _____b. 40% capacity

   _____c. 80% capacity

   _____d. 30% capacity

7. Liquids are always sterilized in a

   _____a. Sterilizing oven

   _____b. Steam sterilizer (autoclave)

8. Normal sterilization cycle in a sterilizing oven is

   _____a. 15 min. at 170° C.

   _____b. 1 hour at 121° C.

   _____c. 15 min. at 121° C.

   _____d. 1 hour at 170° C.

9. To remove dust from a microscope lens do not use:

   _____a. A lens tissue

   _____b. A camel's hair brush

   _____c. A clean handkerchief

   _____d. A quick blow of clean air

10. Microscopes may be carried one in each hand.

    _____a. True

    _____b. False

11. Unsterile pipets may be used in making aseptic transfers.

    _____a. True

    _____b. False

12. Why is a sample tap flamed with a propane torch?

    _____a. To incinerate the bacteria

    _____b. To burn off chemical contaminants

    _____c. Sample taps are not flamed

    _____d. To melt plastic seals

13. What is the dechlorinating agent used in samples collected for microbiological testing?

    _____a. **Sodium hydroxide**

    _____b. Potassium phosphate

    _____c. Sodium thiosulfate

14. What is the type of dilution used in microbiological sample dilution.

    _____a. Parallel

    _____b. Serial

15. Identify the following parts of a microscope on the microscope provided by the instructor.

    a. Eye piece

    b. Oil immersion lens

    c. Course adjustment

    d. Stage

    e. Condenser

    f. Light source

16. Make an aseptic transfer using the equipment provided by the instructor.

Module No:	EVALUATION - Part B
Instructor Notes:	**Instructor Outline:**
	Upon completion of the Microbiological Skills module the instructor shall give the participant Evaluation Part C to complete.
Answers: 1. b 2. b 3. a 4. a 5. a 6. c 7. b 8. d 9. c 10. b 11. b 12. a 13. c 14. b	
15. a. eye piece b. oil immersion lens c. course adjustment d. stage e. condenser f. light source	15. The instructor shall provide a microscope from which the students shall identify the parts given.
16. Performance acceptable to instructor	16. The instructor shall provide all the necessary equipment for proper aseptic transfer of a sample.

SUMMARY

Module No:	Module Title: Manhole Safety
Approx. Time: 8 hours	Submodule Title: 1. Manholes 2. Safety checklist 3. Safety

Overall Objectives:

After successful completion of the course, the student will:

1. Be able to identify the seven (7) common purposes for using manholes.
2. Be able to identify the four (4) basic types of manholes.
3. Be able to describe the six (6) most common dangers found in manholes.
4. Be able to describe the causes of dangerous conditions in manholes.
5. Be able to identify the proper safety equipment to be used when working in manholes.
6. Be able to describe the principles of operation for manhole safety equipment.

Instructional Aids:

Handouts #1 - Manhole Safety
#2 - Manhole Safety Checklist
#3 - Manhole Safety Manual
#4 - Personal Protective Equipment Checklist
#5 - Respiratory Protective Equipment
Transparancy #1
Safety Equipment

Instructional Approach:

Discussion
Lecture
Demonstration

References:

1. WPCF Manual of Practice #9, Design and Construction of Sanitary and Storm Sewers.
2. Manual of Wastewater Operations - Texas.
3. Manhole Safety - A working manual and Information Digest - Iowa State Hygienic Lab (Handout #3).
4. Equipment Manufacturers Literature (may vary depending on type of equipment used).

Class Assignments:

1. Read handouts
2. Sketch types of manholes
3. Participate in class discussion
4. Observe demonstration

Module No:	**Module Title:** Manhole Safety Practices
	Submodule Title: Manholes
Approx. Time: ½ hour	**Topic:** Types of Manholes

Objectives:

Students will identify the four (4) basic types of manholes.

Instructional Aids:

(AV) Overhead transparancies

Instructional Approach:

Discussion
Demonstration
Exercise

References:

EPCF Manual of Practice #9, Design and Construction of Sanitary and Storm Sewers.

Class Assignments:

Students will sketch the (4) four basic types of manholes as illustrated by instructor.

Module No:

Module Title:
Manhole Safety Practices

Submodule Title:
Manholes

Approx. Time:
½ hour

Topic:
Purpose of Manholes

Objectives:

Students shall be able to identify the seven (7) common purposes for using manholes.

Instructional Aids:

Handout #1

Instructional Approach:

Discussion

References:

WPCF Manual of Practice #9, Design and Construction of Sanitary and Storm Sewers.

Class Assignments:

Read handout

Module No:

Module Title:
Manhole Safety Practices

Submodule Title:
Manholes

Approx. Time:
1 hour

Topic:
Common Dangers Found in Manholes

Objectives:

Student shall be able to identify the six common dangers found in manholes, and the causes of these dangerous conditions.

Instructional Aids:

Handout

Instructional Approach:

Discussion
Exercise

References:

WPCF Manual of Practice #1 (Safety), Manual of Practice #9, Design and Construction of Sanitary and Storm Sewers.

Manual of Wastewater Operations - Texas

Class Assignments:

1. Read handout
2. Participate in class discussion

MANHOLE SAFETY - Handout #1

A. Purpose of manholes

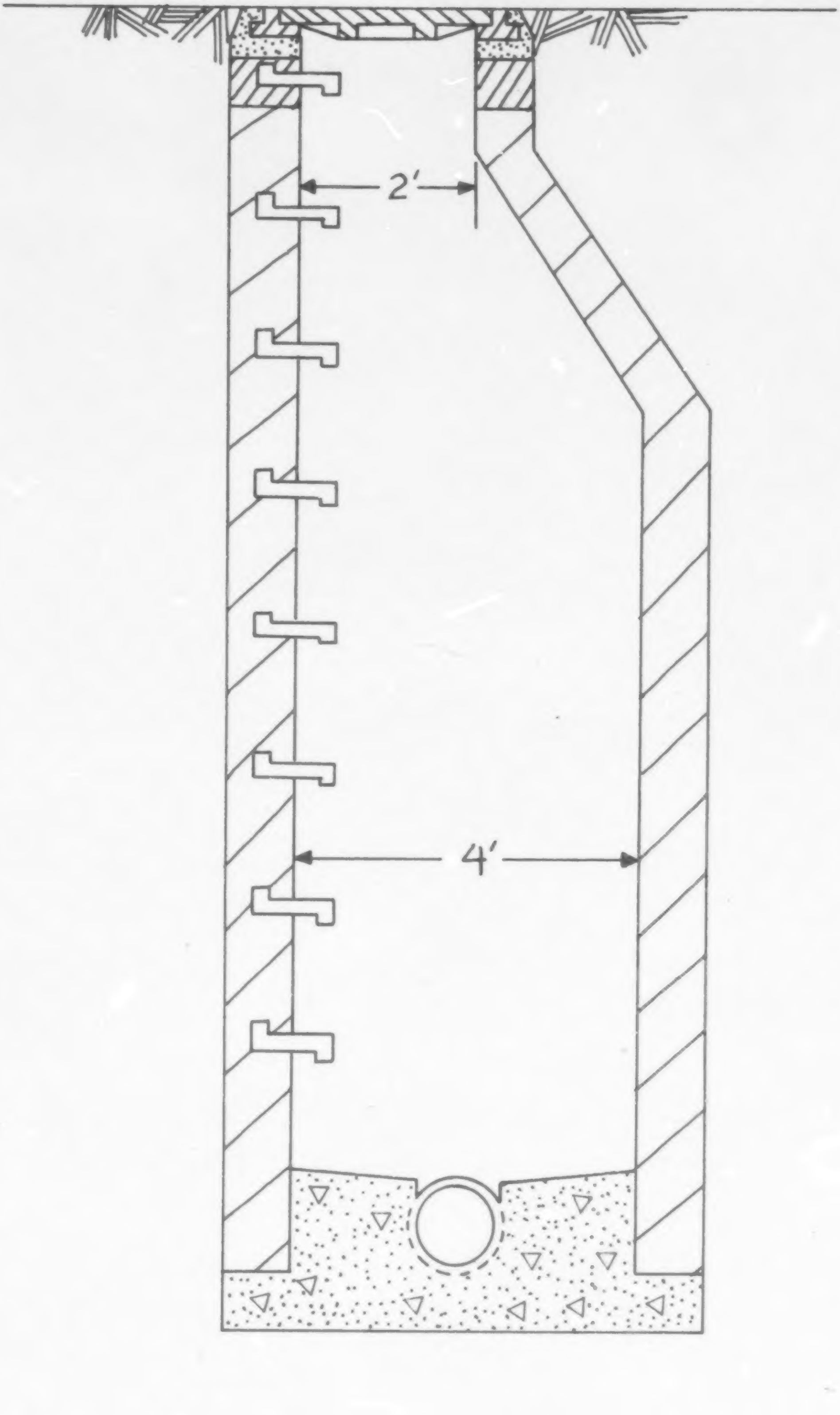
  1. Change in direction of sewer lines
  2. Change in grade of sewer lines
  3. Inspection and cleaning access to pipes
  4. Ventilation of sewers
  5. In treatment plant they may be used for access to underground tanks, pump stations, wet wells and tunnels.
  6. Where two or more sewers connect
  7. Where unequal size lines join

B. Types of manholes

  1. Standard - 5 feet deep or more, most common
  2. Shallow - less than 5 feet deep
  3. Drop - Where difference in invert elevations is greater than 1.5 feet
  4. Pressure - Where high flow level exists, cover is gasketed and bolted

C. Common dangers found in Manholes

  1. Heavy covers - typical street cover weighs 160 pounds, use proper lifting technique.
  2. Loose or corroded steps in manhole
  3. Surges in flow of sewage - if possible divert upstream flow temporarily.
  4. Oxygen deficiency - very common
  5. Explosive gases - methane, gasoline
  6. Toxic gases - Hydrogen sulfide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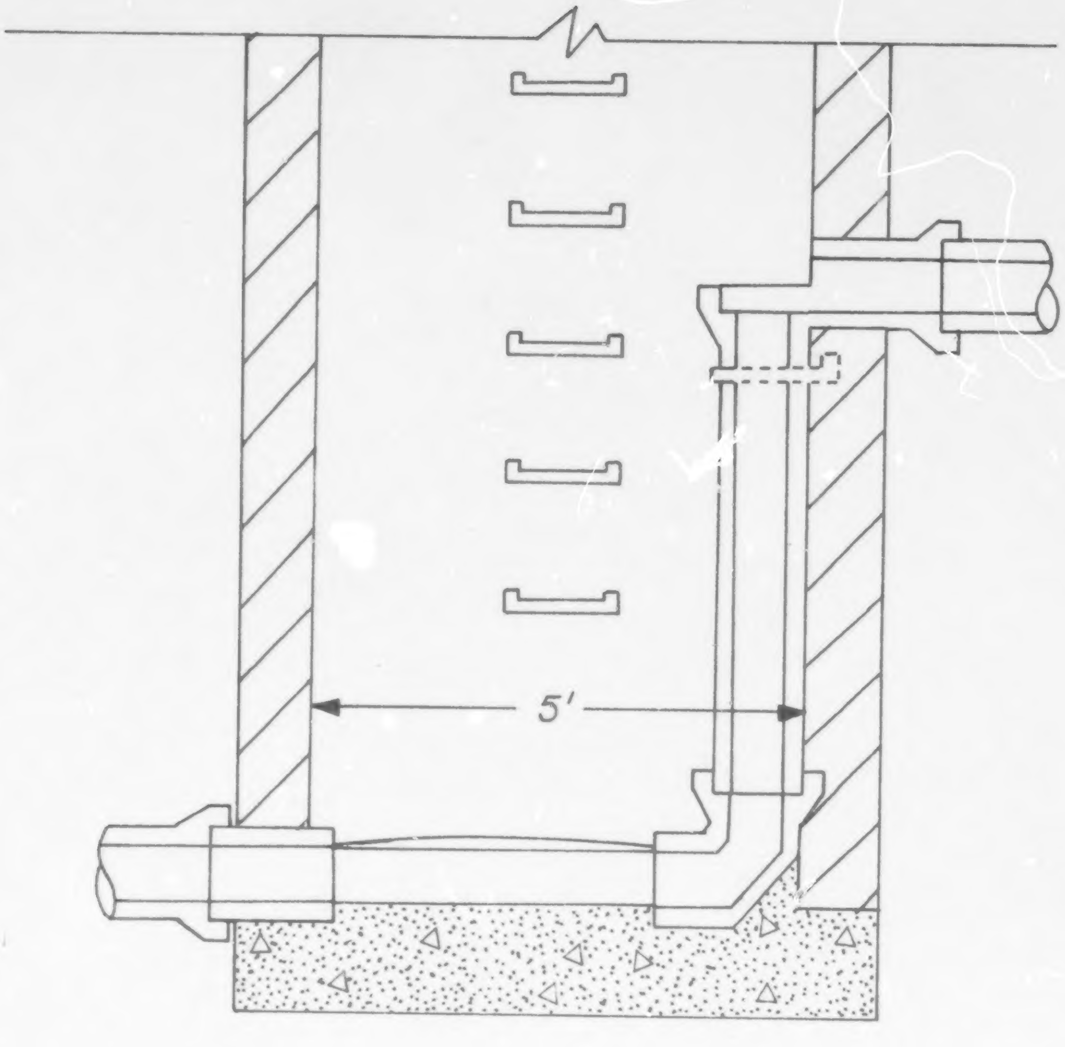
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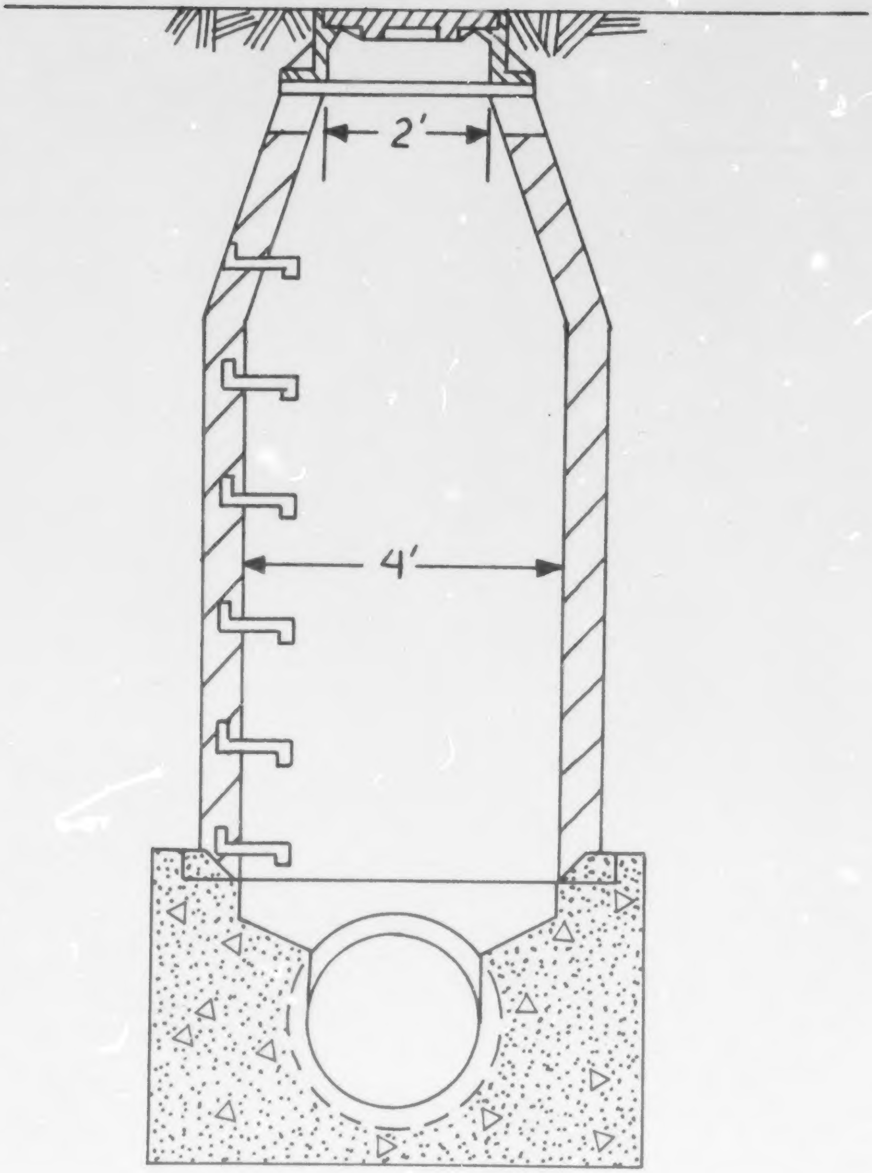

2'
4'

D. Causes of dangerous conditions cont.

1. Low flow velocity - poor design
2. Low flow velocity - stoppage in line low flow velocity can allow the sewage to become septic with the formation of H_2S, CH_4 and other gases as a result, also can lead to oxygen deficiency as result of oxygen demand of sewage. If possible avoid cleaning lines upstream from the manhole you are working in - when unplugged, large flow surge is possible.
3. Poor ventilation - solid manhole covers, long sewer runs (over 400') between manholes blocked lines, also undersized lines which flow full causing sewer to flow full, can all lead to poor ventilation of lines and manholes. Solid covers are preferred because they will not admit runoff from rain etc. Also less danger from vandals throwing debris into holes.
4. Toxic gases - toxic gases other than the ones normally expected (H_2S, CH_4 etc.) may occur. CO will be primarily from exhaust of combustion process, CO_2 in excess of normal valves may be encountered. Cl_2 from prechlorination or wash down after a Cl_2 leak. Also, industrial processes may discharge wastes which can produce gases other than the types normally encountered in manholes. Danger of CO buildup from using engine driven blowers with suction lines placed downwind of exhaust.

5. Hot weather can greatly accelerate the bacterial action which can produce septic sewage and the formation of related gases. Also hot weather can cause the sewage to release gases normally dissolved in the liquid at cooler temperatures. Dissolved O_2 in sewage will drop in warm weather thus leading to move rapid putrification of sewage and greater tendency for septicity.
6. Explosive gases - CH_4 (methane) may occur if the sewage is septic and in an advanced anaerobic condition.

Module No:

Module Title:
Manhole Safety Practices

Submodule Title:
Safety Practices

Approx. Time:
2 Hours

Topic:
Safety Checklist

Objectives:

Given a manhole safety checklist and safety manual the student will be able to explain each of the seventeen (17) items.

Instructional Aids:

Handout #2 - Manhole Safety Checklist
Handout #3 - Manhole Safety Manual
Handout #4 - Personal Protective Equipment Checklist
Handout #5 - Respiratory Protective Equipment

Instructional Approach:

Discussion - Lecture

References:

Manhole Safety - A working manual and information digest
Iowa State Hygenic Lab

Class Assignments:

Read handout
Participate in discussion

MANHOLE SAFETY CHECKLIST - Handout #2

1. Supervision - Buddy System
2. Traffic control - cones, barricades
3. Blower - 200 cfm - 30 air changes/hour
4. Hazardous locations - Unit #1
5. Gas tests
6. Personal protection - see handout on equipment
7. Safety harness - manhole, parachute, write 9/16" lines
8. Ladder - narrow OSHA
9. Electrical - ground fault interrupters explosion proof
10. Tools & work - non sparking
11. Physical agents - noise, heat, light
12. Fire protection - extinguishers
13. Personal hygiene
14. Medical - doctors, hospital
15. Housekeeping - cleanup, inspection
16. Final checks - supervisor - training for crew
17. Accident reports - OSHA

MANHOLE SAFETY - Handout #3

1. Supervision - Buddy

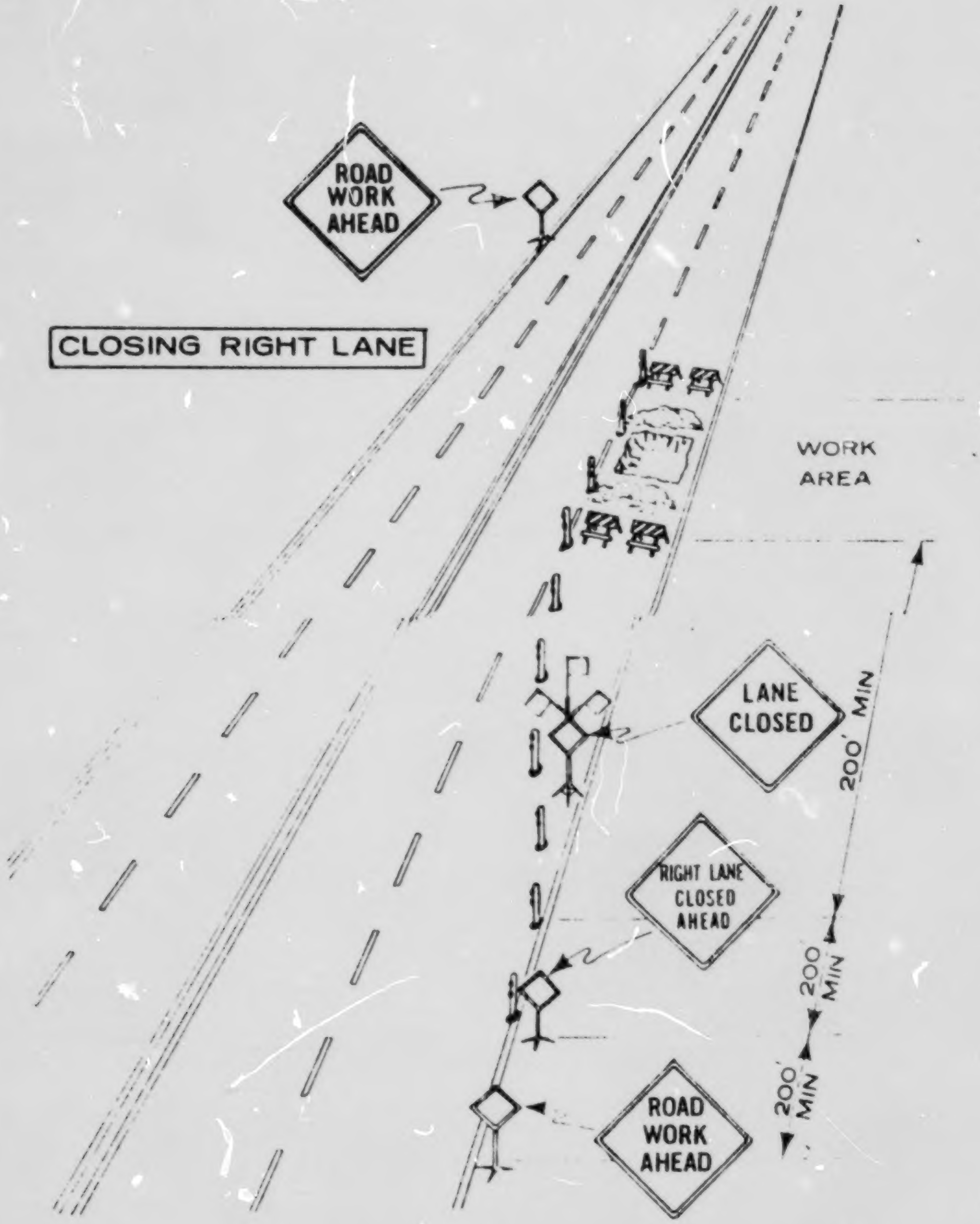
   An attendant(s) should, without exception, be on the surface or outside when a manhole, vessel, or chamber is entered. During the workman's residence, the man outside should keep the worker in view and/or in continual communication. Where conditions indicate that the man inside should use a lifeline, the other shall be on that rope at all times. Facilities to withdraw the worker shall also be provided. Other available workers and winches as examples.

2. Traffic Control

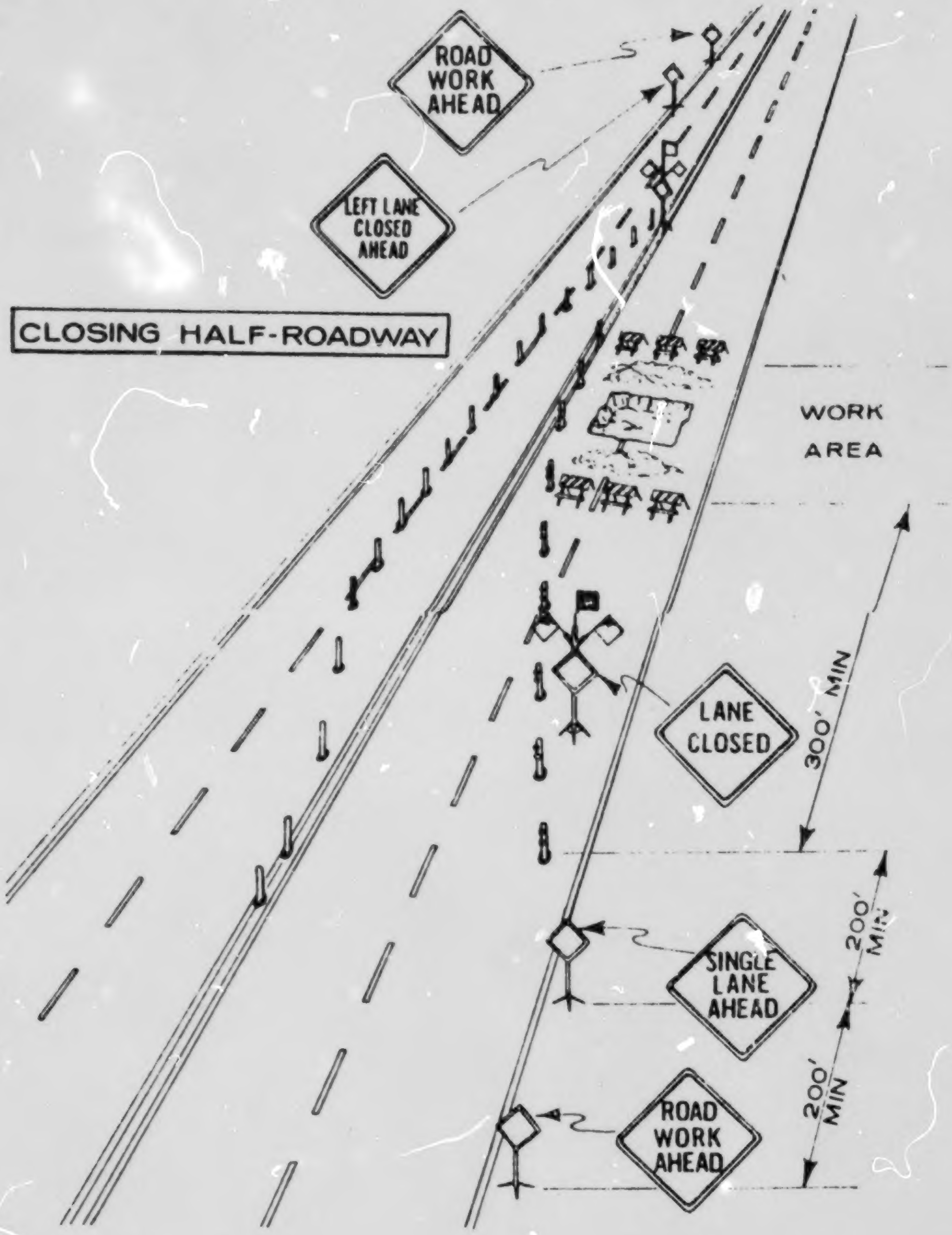
   This refers to the necessary warning signals, barricades (striped), cones holeguarding, fluorescent vests, needed gear and procedures for traffic and work control. These items are referenced, but not enlarged upon in this report. "NO SMOKING" signs and the practice of not smoking may be required.

3. Blower

   A. One blower for each hole should normally be used for every entry. This may include some locations more shallow than five feet. It should include locations five to ten feet in depth. For holes deeper than ten feet, it should be used with tests; see paragraphs 4 and 5 of this report. The use of a blower is indicated for brief entries and holes where no sewage or material with oxygen demand is present. Some entries are made more appropriately with a self-contained or supplied air system.


ROAD WORK AHEAD
CLOSING RIGHT LANE
WORK AREA
LANE CLOSED
200' MIN
RIGHT LANE CLOSED AHEAD
200' MIN
ROAD WORK AHEAD
200' MIN

CLOSING RIGHT LANE
(Courtesy San Diego Chapter, American Public Works Association)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LEFT LANE CLOSED AHEAD
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WORK AREA
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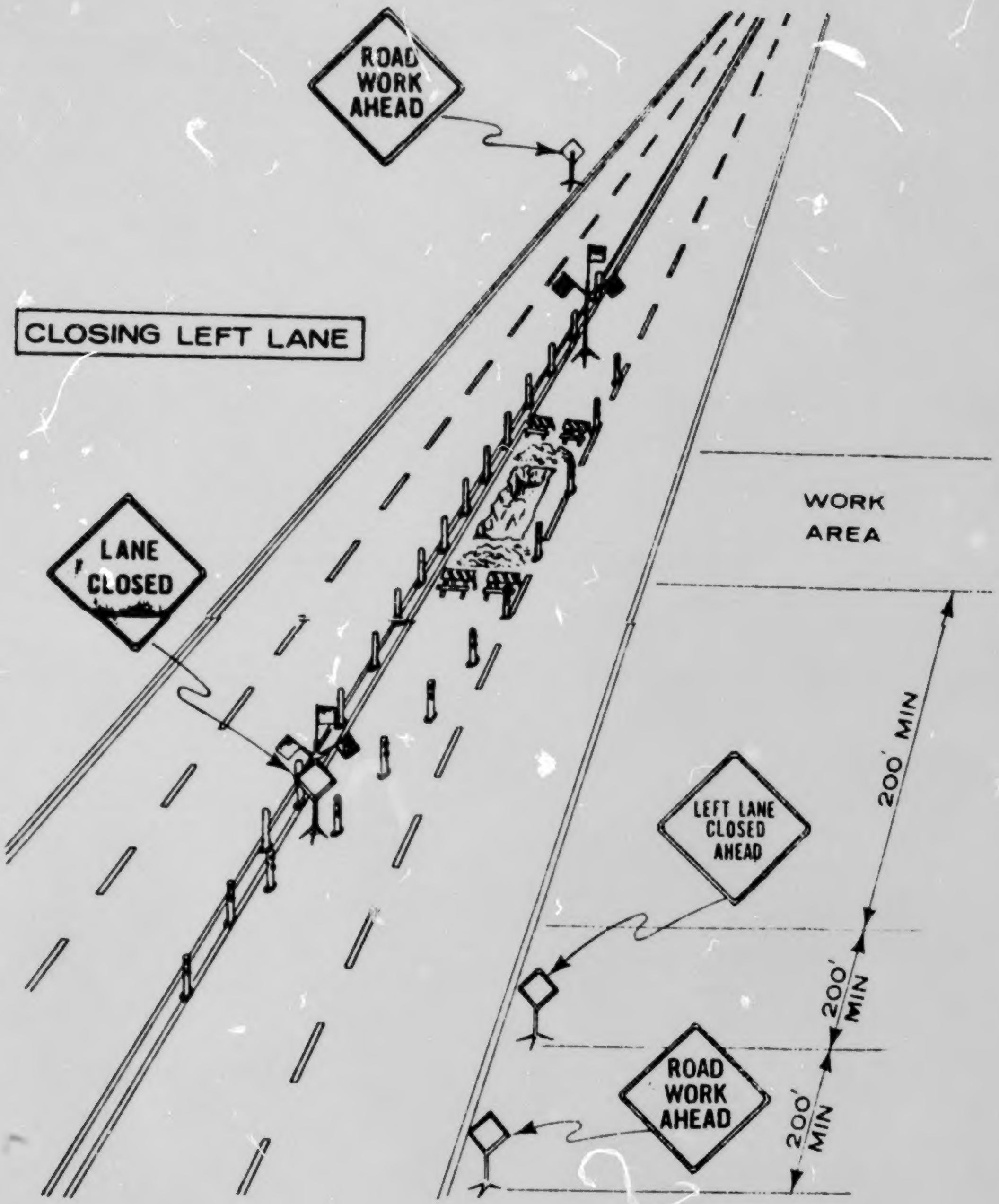
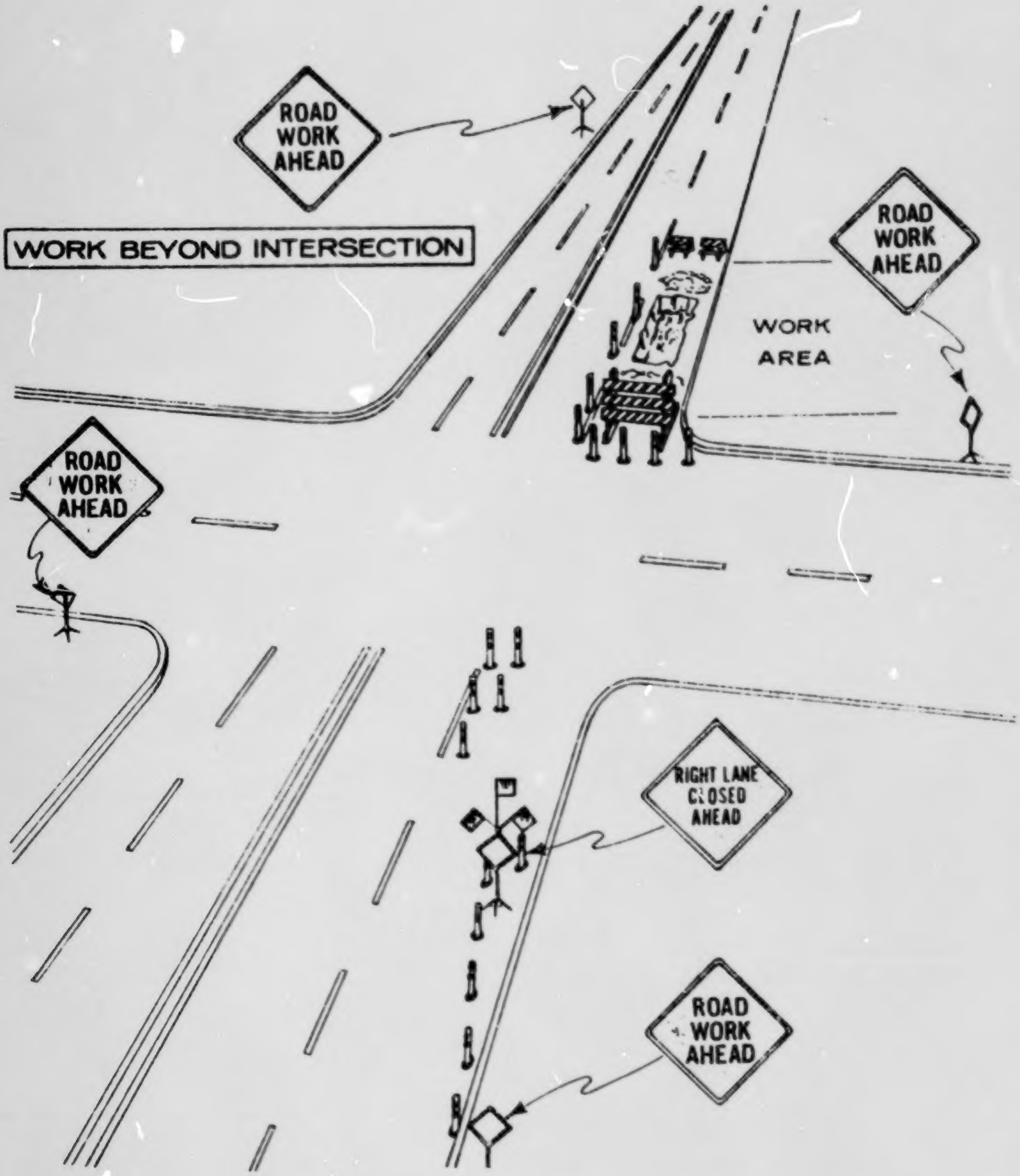
LANE CLOSED
200' MIN
SINGLE LANE AHEAD
200' MIN
ROAD WORK AHEAD

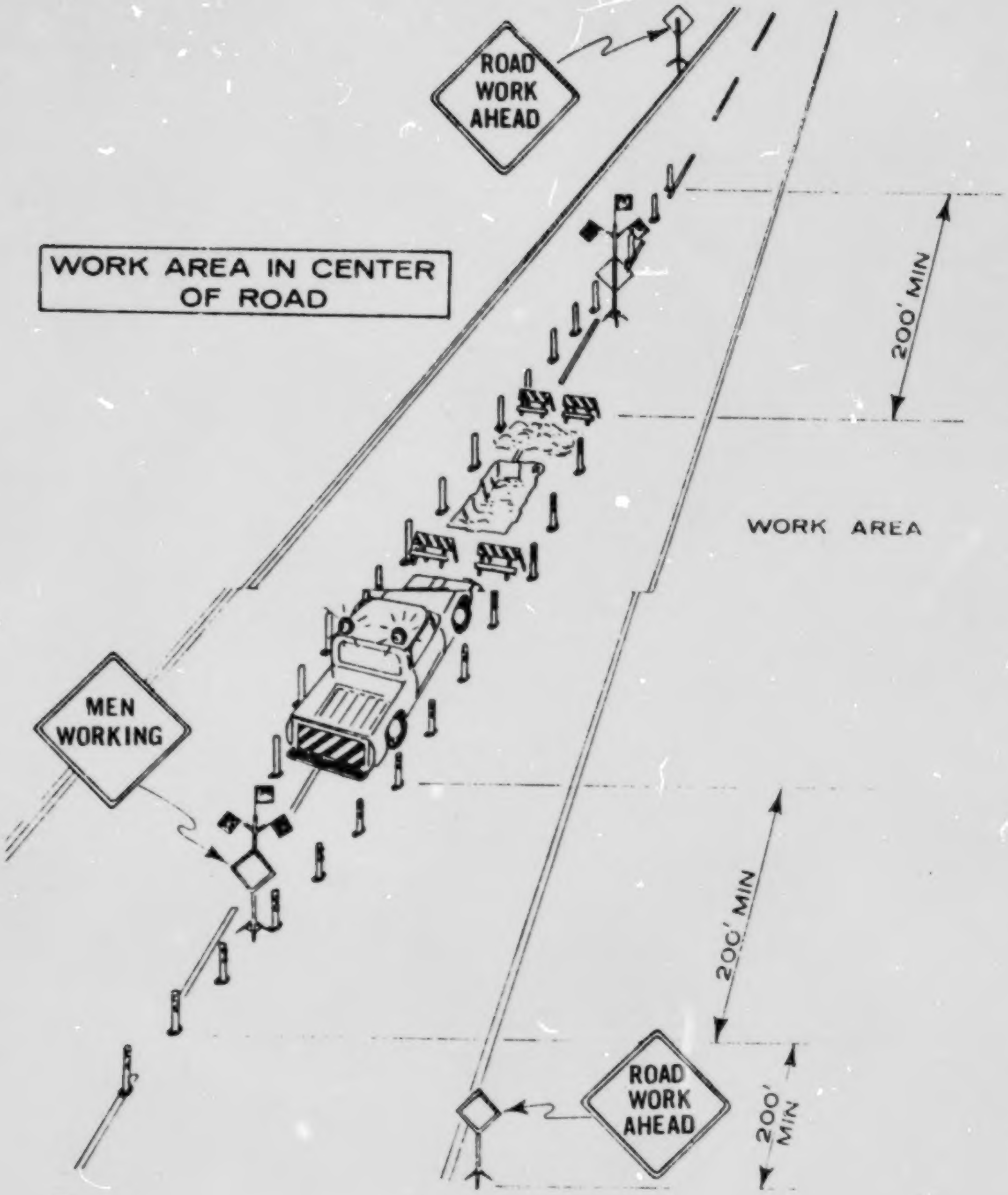
CLOSING HALF-ROADWAY
(Courtesy San Diego Chapter, American Public Works Association)


ROAD WORK AHEAD
CLOSING LEFT LANE
LANE CLOSED
WORK AREA
200' MIN
LEFT LANE CLOSED AHEAD
200' MIN
ROAD WORK AHEAD
200' MIN

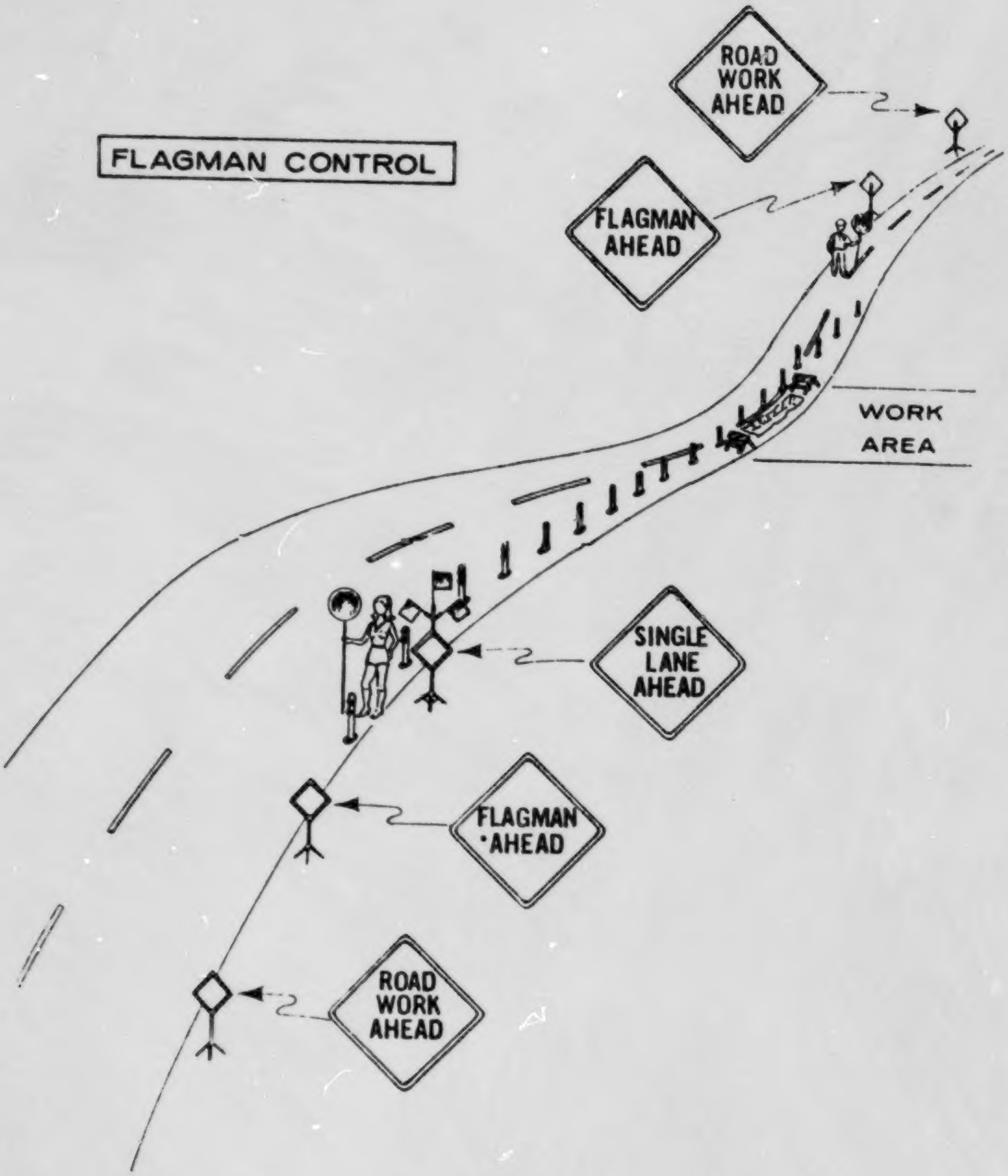
CLOSING LEFT LANE
(Courtesy of San Diego Chapter, American Public Works Association)


ROAD WORK AHEAD
WORK BEYOND INTERSECTION
ROAD WORK AHEAD
WORK AREA
ROAD WORK AHEAD
RIGHT LANE CLOSED AHEAD
ROAD WORK AHEAD

WORK BEYOND INTERSECTION
(Courtesy of San Diego Chapter, American Public Works Association)


ROAD WORK AHEAD
WORK AREA IN CENTER OF ROAD
200' MIN
WORK AREA
MEN WORKING
200' MIN
ROAD WORK AHEAD
200' MIN

WORK AREA IN CENTER OF ROAD
(Courtesy of San Diego Chapter, American Public Works Association)


FLAGMAN CONTROL
ROAD WORK AHEAD
FLAGMAN AHEAD
WORK AREA
SINGLE LANE AHEAD
FLAGMAN AHEAD
ROAD WORK AHEAD

FLAGMAN CONTROL
(Courtesy San Diego Chapter, American Public Works Association)

B. The blower should operate continuously during work, providing 30 changes of air per hour for the effective volume entered (see airflow paragraph 5). A minimum of 12 changes of air should occur before entry. Where extensive amounts of stagnant organic matter, for example, sewage is exposed, hydrogen sulfide and other tests should be made to be sure that a safe atmosphere exists. Gas can, in some cases, be given off at a rate that the usual ventilation is not adequate.

C. The direction of airflow should be noted. This can be visualized by a puff of powder, for example, starch or talc, or a chemically generated smoke. A fire generated smoke may be a serious risk. Changes in airflow during the course of work must be noted.

   1. If air moves into the confinement, this may assist ventilation.
   2. If air is stagnant, air contamination accumulates and oxygen may be depleted.
   3. If air is moving out of the confinement, impurities may be brought from other sections of the sewer. It is important to place the blower discharge where it will be effective. Adequate capacity is also required.

D. Keep exhaust funes out of the blower intake. Though this is an obvious hazard, the condition has been observed, and must therefore be consciously considered.

4. Hazardous Locations

The ones listed require precautions in addition to the blower and supervision. A minimum of explosibility, oxygen, and normally hydrogen sulfide, should be made in the following:

A. All sewers and manholes more than 10 feet deep.

B. Any tightly covered pit, tank or valve chamber, regardless of depth (solid covers).

C. Deep tanks, sludge digestion tanks, and pump suction wells.

D. All large trunk sewers.

E. Sewers located in the vicinity of gas mains or gasoline storage tanks.

F. Sewers from industrial areas.

G. Sewers on flat grades or constrictions where solids may settle and decompose.

H. Sewers with manholes over 300 feet apart.

5. Gas Tests

Use an instrument that works, and for which the calibration is verified.

Both field and laboratory tests should be made on test instruments to insure proper operation. This includes that they are free of leaks, have the proper flow rate, and give the correct reading. Some of these tests (e.g. leak test) should be made frequently in the field. Other tests may have to be made in the shop, office, or in a laboratory. Verification of a few points of operation may be adequate. Test contaminated air solutions can now be purchased from suppliers, or prepared in municipal laboratories or consultants laboratories. Refer to the supplier's manual for information. References list some suppliers of these devices, most of which are already distributed in Iowa by a safety equipment supplier. Several vapors or gases that may be encountered can be tested. The "pilot" ones are listed below for usual tests, though others may be present. Long probes or tubes for sampling are desirable so that tests can be made before entry, perhaps through the holes in the cover. Note the airflow into or out of the manhole. If it is necessary to have a man enter the chamber to test, a safety harness (see Item 7 this report) shall be mandatory.

No OSHA reference is given to directly require tests of sewers to be made, but after an accident you will (we understand) be required to show proof that these had been made. A need for such measurements is illustrated in a series of accidents and standards (including the 1st edition of this report) in most cases documented before the OSHA law.

Get out of the sewer if you feel dizzy, sleepy, nauseated, if it becomes hard to breath, or if water starts rising.

A. Explosibility

The combustible gas indicator to measure "explosibility" should provide a first test. It should be a reliable model, zeroed in the field before using insensitive to high humidity, and verified for proper readout occasionally with a "standard" gas.

The usual model reads from 0 to 100 percent of the Lower Explosive Limit (LEL) to detect methane and gasoline, etc. at explosive levels. New models should be considered that read full-scale. 0 to 1,000 parts per million (ppm) (12,000 ppm is LEL of toluol) sensitive scale provide important information on many materials at their toxic levels. OSHA inspectors are using this instrumentation with sensitive scales (Communications not referenced). Mine type lamp detectors have not found favor in sewage works.

B. Oxygen

18% minimum oxygen is necessary before entry. Since oxygen is both absorbed by the biological demand (BOD) and displaced by other gases (e.g. carbon dioxide and methane) this check should be routine. In low oxygen, flammable gases will not properly register as combustible on indicators.

Instruments should be chosen for long-term reliability. Some sensor cells must be reconditioned several times per year, may be expensive, and variable. The cell should NOT foul on hydrogen sulfide; a common gas in sewage problems and a common failing of several types of cells.

C. Hydrogen Sulfide

Hydrogen Sulfide should be suspected and tested at EVERY location where sewage or organic matter is present and subject to bacterial action. It is usually prevalent where sewage has been stagnant even a short time.

As it has an anesthetic effect on the ability to small, it seems odorless - or becomes so. It has been observed to generate rapidly enough that blowers do not completely handle it. Rechecks should be made frequently during work, where indicated.

1,000 to 2,000 ppm results in unconsciousness with early cessation of respiration and death in a relatively few minutes. Five hundred to 700 ppm results in loss of consciousness and possibly death in 30 minutes to one hour. Some irritation was reported as low as 10 ppm.

A wide range of instrumentation is available to test the H_2S from the classical chemistry laboratory paper soaked in lead acetate, through detector tubes and modern continuous detectors. A fixed rate of airflow over the detector is required for precise measurement. The automatic devices are recommended for use in some plant operations. Operation of the sensing devices should be verified frequently. Leaks, incorrect flow rates (even reverse flow) and other difficulties have been observed with various models.

D. Sewer Gas

Is a general term describing a wide range of possible mixtures. On-site control can often be made by testing of the previously mentioned gases as "pilot" gases. These additional constituents may sometimes complicate the problem, or give difficulty independently.

1. Carbon Dioxide - CO_2, TLV = 5,000 ppm

   This gas has been found in manholes; with and without sewage, with and without an oxygen deficiency. It increases the respiration rate and gives an oppressive feeling.

2. Carbon Monoxide - CO, TLV = 50 ppm

   The usual source is from motor exhausts either from the blower air or from a remote area. Tests should be made where indicated and often simply as a good precaution.

   Instrumentation is typically by detector tubes or instrumentation including some sophisticated types. The OSHA teams normally, we understand, have applied detector tubes, or hand-held instruments such as hopcolite or newer detector devices. Calibration gases are now available to verify the measurement.

This gas standard is recommended in addition to battery, leak, flow, and other tests.

3. Other sewer gases

A host of other gases may be found in sewage, either as a product of putrefaction or in specific areas of a plant from auxiliary treatment such as disinfection by chlorine or deodorizing by ozone. Innumerable gases may be present, which are not listed here, but would be ideally controlled by good ventilation and "pilot" test of the appropriate major constituents.

Test devices vary widely from detector tubes, field direct reading, to sophisticated continuous measuring instruments. The choice depends on the characteristics of the gas, the need to test repetitively, calibration requirements, etc.

Ammonia, NH_3 - TLV = 50 ppm

Methane, CH_4 - Simple asphyxiant, no TLV, 18% O_2 minimum explosive.

Organic Acids e.g. Acetic Acid - TLV = 10 ppm.

Phosphine - TLV = 0.3 ppm

Chlorine - TLV = 1.0 ppm

Ozone - TLV = 0.3 ppm

Nitrogen Dioxide - TLV = 5 ppm Ceiling

E. Industrial

A wide range of materials including gases may be emitted from industrial processes. Their source and nature should be traced for a good base on which to resolve the problem. Toxic, explosive, radioactive materials are examples. The examples listed do have a volatile component and have been observed in Iowa. The cyanide was from plating wastes, the gasoline was from a service station leak.

Hydrogen cyanide - TLV = 10 ppm (is skin absorbable)

Gasoline - TLV = Approximately 500 ppm. This is an explosive mixture for which specific components (e.g. tetraethyl lead and aromatics) may lower the TLV significantly.

6. Personal Protection

Personal protective devices are "personal" inasmuch as they must fit specifically the individual that wears the device(s). Especially check fit to individual, proper choice (gases are NOT filtered by dust cartridges); do several items work when worn together, or do they fall off. Full-face self-contained supplied air respirators may be considered.

Through the OSHA philosophy correctly expects engineering design to correct problems in work areas, some need for protective gear will always be required for field operations. Safety glasses and other items will be needed supplement for a long time.

A. Hard hats must be usable in tight places.

B. Hearing protection, earmuffs (No soiled material into the ear)

C. Safety glasses, and face protection

D. Supplied air (preferably), or respirator. A respirator will not function in low oxygen, must be chosen for the right contaminant.

E. Safety belts, lifelines and lanyards.

F. Clothing, boots, gloves, etc. Fluorescent vests - attendants should be visible to all traffic at all times.

G. This list is indicative; individual conditions may require an appropriate choice of gear.

H. Lasers used only by trained workers (red color usual).

7. Safety Harness, Rope, Attendant

The safety harness and rope should be worn in the locations listed as hazardous. An attendant should be present even in the areas not listed, as pits less than 10 feet deep. A spare rope and harness should be available. Spare manpower and means of recovery should be provided.

8. Ladder

Adequate means of safe and rapid entrance and exit (egress) is needed. Ladders, whether permanent or portable should meet current specifications for the appropriate application.

9. Electrical

The presence of moisture in sewers and many plant processes makes good electrical practice a necessity. Proper grounding and bonding of the equipment precludes most of the chance for the worker to become a part of the circuit. The new generation of "ground fault interruptors" have an immediate wide application for this type of work. Solvents may be a problem.

Where vessels are entered usually within treatment and process plants, a lockout procedure is required to stop powered equipment.

"Explosion proof" equipment, usually Class 1, Division 1 is required for lights and power gear in certain locations.

Where power lines are encountered, buried or overhead, the electrical power company should provide the appropriate supervision and workers.

10. Tools and Work

Work carried out in a confined space may cause fumes or other conditions to change with time so that an awareness of the situation should be continuing throughout the job. Observed cases include the release of gases when a quiescent material was agitated, and the release of fumes when welding. Other hot processes are a problem source.

The new generation of "Ground Fault Circuit Interrupters" for personnel protection provides a new tool for safety in the typical sewer environment when power tools are used.

A. Need spark-resistant hand tools where an explosive level is probable.

B. Power tools may need to be Class 1, Division 1 or they may produce sparks to ignite fumes during use, regardless of electrical design. Consider the conditions involved in each problem situation.

C. Welding, cutting, brazing, soldering, heating. This may be an electrical hazard directly. Fumes from the metals used for the process may involve fluorides, as well as metals. Plating materials include lead, zinc, cadmium and others. Heated plastics, especially when scorched, release a host of fumes and should be avoided. A smell may be too much though odor may be a practical field test since laboratory grade evaluation is difficult and time consuming. These coatings may burn.

D. Solvents should ideally be swept out of sewer areas by the blower air. These should be reviewed for toxicity in the TLV tables, fire, and decomposition products.

11. Physical Agents

Several areas require comment, other agents may be a problem in special cases.

A. Noise is a problem if you have to shout to be heard by a fellow workman who is standing next to you. Measurements would be expected to confirm that noise from most jackhammers and large power drills is excessive for any but brief exposure. Personal protection would be indicated on all jobs of a temporary nature. Earmuffs would be suitable, hygiene problems make ear plugs undesirable on many jobs involving sewage.

B. Light should be adequate, without excess glare, and not be a fire hazard. The current application of lasers to construction alignment, etc., requires several cautions so the operator doesn't look directly at the light source. Some of the construction lasers are limited in power and type, but require good work practices.

C. Heat stress poses limits which can be read by instruments that measure a composite of temperature, humidity, radiant heat and airflow simultaneously (Wet Bulb, Globe Temperature).

12. Fire Protection

The main object to handle materials and work so that a fire does not ignite, should be followed up by knowing in advance the action to procure assistance from the fire department. Special problems affecting the fire fighting effort should also be considered in advance.

13. Personal Hygiene

Wash hands thoroughly before eating. This should be practiced regularly. Packing food in plastic bags in lunch boxes can be easily done to meet good practice.

Hand to mouth contact can also be made or avoided by the way a cigarette (if used) is handled. The simple, unconscious habit of touching one's lips, a nearly universal habit (look around in any friendly group), is most undesirable. These actions may be supervised, but are largely an action that has to be changed by the worker.

Sanitary facilities should be available, including the portable outhouse, if necessary.

This area should be extended after work by complete changes of clothes and a shower (include hair).

Potable water should be available.

14. Medical

Several areas are specified by OSHA. Good practice should provide continued maintenance of the capabilities needed.

A. First aid training and equipment for a relatively serious accident should be available immediately to every worker in the field as well as at the plant. This is well defined by OSHA regulations, but competent follow-up is indicated.

B. Physician and hospital access is a self-evident requirement for both field and plant workers. These are also defined by the OSHA regulation, and should be followed systematically.

C. Immunization and the physical condition of the worker are only two of several additional areas where a physician should be consulted for an adequate medical program. Tetanus immunization is one of the obvious shots to be given. Several others may be considered, especially in areas where special problems may exist. These actions should be taken before accidents happen.

Physical examinations should also be carried out under the direction of a physician.

Both of the above areas may be difficult to administer where the worker population involved is transient, and may not be fastidious. The problem of follow-up does, however, remain.

15. Housekeeping

Good housekeeping correlates with good safety records according to the consensus of most safety inspectors with whom we have had contact.

16. Final Checks

Supervision and workmen that make the "final check" of an installation need an extra bit of caution. Several of the SHL field studies involving a sewer accident were partially described as:

"He just went down for a last look"

"They went down to get blueprints left at the end of work"

It is recommended that supervision use the checklist provided in actual cases. Follow-up on detail through references can be made where indicated.

17. Accident Reports

When an accident has occurred (in spite of prior efforts) the first action is to provide for the victim, or patient. Follow-up is needed to provide information to prevent future accidents, hopefully learning from past mistakes. Legal and other records are also required. OSHA and IOSHA have provided avenues for such reporting.

All fatalities, major accidents, and report forms should be communicated to:

Commissioner of Labor
State Bureau of Labor
State Office & Laboratory Bldg.
East 7th & Court Streets
Des Moines, Iowa 50319

Phone: 515-281-3606

Module No:	**Module Title:** Manhole Safety Practices
	Submodule Title: Safety Practices
Approx. Time:	**Topic:** Safety Equipment

Objectives:

The student shall be able to identify, describe principles of operation and operate properly manhole safety equipment.

a. Safety harness
b. Self-contained breathing apparatus
c. Oxygen deficiency test meter
d. Combustible gas test meters
e. Toxic gas test meters
f. Detector tube test kits

Instructional Aids:

Safety equipment

Instructional Approach:

Discussion
Demonstration

References:

Manufacturer's literature

Class Assignments:

Observe demonstration
Participate in discussion

PERSONAL PROTECTIVE EQUIPMENT CHECKLIST - Handout #4

1. Safety toe shoes
2. Safety toe hip boots or chest waders
3. Safety hat (hard-hat)
4. Eye protection (glasses, goggles, shields, etc.)
5. Hearing protection (over the ear, muff type)

THE ABOVE ITEMS MUST BE OSHA APPROVED

Other suggested equipment for each collection system worker:

6. Raincoat - heavy rubber or rain-suit
7. Rubber gloves - short & long styles
8. Extra uniform or clothes

RESPIRATORY PROTECTIVE EQUIPMENT - Handout #5

I. Human Needs and atmosphere facts

  A. Normal air contains 20.9% oxygen at sea level.

  B. Oxygen content of air decreases as altitude increases.

  C. 19.5% oxygen is minimum needed to support human life.

  D. The following items will directly effect the amount of air needed by man.

    1. The degree of physical activity

    2. Physical condition

    3. Emotional conditions

II. Respiratory Protective Equipment

  A. Cannister type respirators

    1. Use can containing filter or chemical to absorb contaminants in the atmosphere.

    2. Not suitable for oxygen deficient atmospheres as they do not add oxygen to users air supply.

    3. Each class or type of cannister is only suitable for specific types of contaminants.

    4. Cannister type respirators are not recommended for use in manholes.

  B. Compressed Air breathing apparatus

    1. Self-contained breathing apparatus - user wears air supply tank on his person. Air supply can vary from as low as 5 minutes up to 45 minutes. Large tanks may be too heavy and bulky in manholes.

2. Supplied air breathing system - similar to SCBA except large supply tanks (1 to 6 hours supply) are used at remote location, and user is connected by air line. Escape bottles (5 to 10 minute supply) should be carried on the person in case main supply line is cut or main supply runs out.
3. General information (applies to both systems). Breathing apparatus will provide only respiratory protection and protection for facial areas covered by supply mask. It is best to select a breathing apparatus which will completely cover mouth, nose, and eyes. Deflectors should be mounted in the nose area of the mask to prevent fogging. Persons who wear eyeglasses should have lenses mounted in the mask to prevent leakage around the bows of the glasses. Also facial hair beards, long side burns and very long hair should not be worn by persons using breathing apparatus as leakage may occur.
4. Service life of compressed air cylinders may vary from manufacturers ratings due to following factors:
    a. Physical and emotional condition of user.
    b. Pressure in cylinder at start of use.
    c. Training and experience user has had with equipment.
    d. Presence of CO_2 (carbon dioxide) in air supply at levels greater than 0.4%.
    e. Atmospheric pressure, as pressure increases, duration decreases.
    f. Condition of apparatus.

Module No:	Module Title: Manhole Safety
	Submodule Title:
Approx. Time: 1 hour	EVALUATION - Knowledge Skills

Objectives:

The students will answer at least 7 or 8 questions with complete accuracy on the written test.

1. List 5 of the seven common purposes for using manholes.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

2. Sketch or describe the four common types of manholes.

   a.

   b.

   c.

   d.

3. List the six common dangers found in manholes.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

4. Waist belt safety harnesses are acceptable for use in manholes.

a. True _____

b. False_____

5. MESA and OSHA approval are required for most safety equipment used in manholes.

a. True_____

b. False______

Circle the best answer(s)

6. The use of blowers to ventilate manholes can be dangerous because

a. They operate at high temperatures.

b. They create excessive noise.

c. Carbon monoxide may be introduced into the manhole.

d. The blower may not have a high enough air delivery capacity.

7. Cannister type respirators are not acceptable in oxygen deficient manholes because

a. They don't contain enough breathing air.

b. They do not add oxygen to the breathing air.

c. There is a danger of explosion when using them.

d. They are only made for chlorine.

8. The most useful type of breathing apparatus for use in manholes is

   a. Cannister type respirator

   b. Self-contained breathing apparatus

   c. Air-line breathing apparatus

Page 1 of 1

Module No:

Module Title:

Submodule Title:

Approx. Time:

EVALUATION Practical Skills

Objectives:

The student shall be able to demonstrate the following skills, to the satisfaction of the instructor. The equipment will be provided by the instructor.

1. Put on a safety harness and show proper hookup and use of safety lines.
2. Put on, use, take off, and clean up a self-contained breathing apparatus.
3. Set up, calibrate, use, and interpret readings of the following test instruments.
    a. Oxygen test meter
    b. Combustible gas meter
    c. Toxic gas meter
    d. Detector tube kit

III. MEASUREMENT

A. Design

Four types of measurement exist which are incorporated into the water/wastewater program at Kirkwood: (1) Course effectiveness; (2) Instructor effectiveness; (3) Student skills performance; and (4) Post-graduate job performance.

The effectiveness of courses and instructors in the water/wastewater program are still in their infancy. The method of evaluating course effectiveness is done through a campus-wide computer scored evaluation system called "SPOT". Course evaluation is generally done when students complete the requirements of their program at Kirkwood. "SPOT" course evaluation fits into the program goals well, because of Kirkwood Community College's commitment to competency-based education.

The nature of the competency-based curriculum has provided a natural means of evaluation of student performance. Some courses do not have a criterion level of 90% efficiency, but the program generally maintains at least a 85% criterion performance levels. Module revisions are still being made.

Two methods of determining student skills levels have been developed: (1) Entry skills tests proved by the instructor for basic math skills essential for success in the water/wastewater program; and (2) Instructor referral of student to "PAD" for reading and math skills deficiences and specific terminology and concepts development. "PAD" is a college wide reading and math development center which provides individualized testing, tutoring and remedial services to all students of Kirkwood.

Last year the Water/Wastewater Technology program was able to place 100% of their graduates. The Water/Wastewater Department at Kirkwood tends to be one of the first places plant administrators contact when job vacancies occur. Specific means of evaluating graduate job performance is still in the revision stage of development.

B. Development

The four methods of measurement being used in the program were developed by instructional staff of the Water/Wastewater Technology Department or developed by Kirkwood evaluation staff and Water/Wastewater Technology staff jointly (i.e. "SPOT" and "PAD") for the water/wastewater program. Much of the evaluation instruments are still at the revision/field testing stage and require additional modifications and additions. The modules are requiring most of the revisions and additions being made.

Post-graduate follow-up is the area presently being developed. Copies of "PAD" and "SPOT" evaluations and remedial services are located at the end of this report.

C. Evaluation

The methods used to measure the competency levels of students, instructors, courses and programs were chosen with specific purposes identified. Personnel employed at Kirkwood in the evaluation division have given input and guidance throughout the development of this program in their area of expertise.

This project has been hampered by several factors which have caused the goals set to be somewhat ambitious for the time and personnel available. Most goals were achieved, but to varying degrees of completion. Time limitations were the largest single thwarting factor. But other factors delayed the developmental process: (1) The necessity of replacing a curriculum developer at the end of May, 1977; (2) The very nature of the evaluation hampered the availability of results and completion of evaluation instruments; and (3) The difficulty for instructors to find time for this project beyond their everyday teaching loads.

Evaluation forms used in the revision of competency based modules.

Research Dept.

Dear Student,

The purpose of this questionnaire is to measure your general attitudes and feelings toward your present program of study at Kirkwood. On the following page are twenty-five(25) pairs of words; each pair contains two words that have opposite meanings. Between the words of each pair are seven (7) spaces. If you feel strongly that one of the words in the pair describes your program, place an "X" in the space closest to that word. If you feel that one word in the pair describes your program, however the word does not strongly describe your program, place an "X" in the second or third space from the word. If you feel neutral regarding a pair of words, or if you feel that they do not apply to your program, the "X" should be placed in the middle space.

Please work at a fairly high rate of speed through this questionnaire. Do not worry or puzzle over individual items and do not try to remember how you checked previous items. Remember, it is your first, but honest impression that is important.

Thank you for your cooperation.

KIRKWOOD COMMUNITY COLLEGE

This form was designed to provide feedback to the instructor and/or staff on selected aspects of instruction or program outcome. Your response should reflect your individual perceptions. Below are a series of statements which may or may not be consistent with your experience of this course, program or instructor. Consider each item separately. First decide whether you generally agree or disagree with the statement; then indicate the strength of agreement or disagreement by marking the appropriate space. Please use a pencil.

IDENTIFICATION NO.

	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

1.1 Were written course objectives given out at the beginning of the course?

1.2 Were course objectives explained by the instructor.

1.3 Were course objectives clear and understandable.

1.4 Was there enough time to learn course objectives.

2.1 Did course content cover course objectives.

2.2 Was course difficulty appropriate for your background?

2.3 Were course learning activities relevant and worthwhile?

2.4 Were textbook and/or other reading materials understandable?

2.5 Were films and other audio-visuals appropriate to course content?

2.6 Was the course interesting to you?

3.1 Did the instruction help you learn the course objectives?

3.2 Did the films and/or other audio-visuals help you learn the course objectives?

3.3 Were assignments and activities related to the course objectives?

3.4 Did the course progress at the right speed for you?

4.1 Were coarse tests and graded activities taken from course objectives?

4.2 Did course tests adequately cover what was learned?

4.3 Were test results quickly returned to you?

4.4 Were course requirements and grading procedures clearly understood?

AGREE			DISAGREE			
STRONGLY	MODERATELY	SLIGHTLY	STRONGLY	MODERATELY	SLIGHTLY	
						1
						2
						3
						4
						5
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						20
STRONGLY	MODERATELY	SLIGHTLY	STRONGLY	MODERATELY	SLIGHTLY	
AGREE			DISAGREE			

1. 1 2 3 4 5 6   2. 1 2 3 4 5 6   3. 1 2 3 4 5 6

4. 1 2 3 4 5 6   5. 1 2 3 4 5 6   6. 1 2 3 4 5 6

KIRKWOOD COMMUNITY COLLEGE PROGRAM

discouraging ____:____:____:____:____:____:____ inspiring
beneficial ____:____:____:____:____:____:____ unhelpful
rigid ____:____:____:____:____:____:____ flexible
creative ____:____:____:____:____:____:____ restrictive
enjoyable ____:____:____:____:____:____:____ unpleasurable
unfair ____:____:____:____:____:____:____ fair
hard ____:____:____:____:____:____:____ easy
lively ____:____:____:____:____:____:____ sluggish
dull ____:____:____:____:____:____:____ interesting
understandable ____:____:____:____:____:____:____ confusing
costly ____:____:____:____:____:____:____ inexpensive
tense ____:____:____:____:____:____:____ relaxed
organized ____:____:____:____:____:____:____ chaotic
monotonous ____:____:____:____:____:____:____ stimulating
rewarding ____:____:____:____:____:____:____ frustrating
lenient ____:____:____:____:____:____:____ strict
fast-moving ____:____:____:____:____:____:____ tedious
irrelevant ____:____:____:____:____:____:____ relevant
unpleasant ____:____:____:____:____:____:____ pleasant
simple ____:____:____:____:____:____:____ difficult
boring ____:____:____:____:____:____:____ challenging
good ____:____:____:____:____:____:____ bad
unfulfilling ____:____:____:____:____:____:____ self-satisfying
dispensable ____:____:____:____:____:____:____ essential
worthwhile ____:____:____:____:____:____:____ valueless

Research Dept.

COURSE SURVEY

Dear Student,

We need your help in our effort to provide the highest quality of education at Kirkwood Community College. We would like to determine through an analysis of the present situation what method of instruction is the best one to employ. That is why we have come to you for information. "Method of instruction" does not refer to what is being taught, but rather to the manner or way in which it is being taught. Please try to be as honest as you can in answering these questions. Your cooperation will be instrumental in aiding us to maximize the quality of instruction at Kirkwood.

Thank you for your help.

DIRECTIONS

1. Please use a SOFT (#2) pencil.
2. Do not write your name on the answer sheet. Instead of your name, write in the boxes provided for name, the name of your program of study. For example, Auto Collision, Medical Assistant, etc.
3. Write, in the indicated place on the answer sheet, the name of your instructor and the name of your class.
4. Begin with Question #1, and remember to move horizontally across the answer sheet.

---

1. With the method of instruction used in this class I am treated as an individual.

   A. True, all of the time
   B. True, most of the time
   C. True, only some of the time
   D. Seldom true
   E. Never true

2. Does the method of instruction used in this class permit students to progress at their own rate?

   A. Yes, definitely
   B. Yes, to some degree
   C. I don't know
   D. No, it tends to keep everyone moving together
   E. No, definitely

3. My ability to learn in the method of instruction used in this class ....

   A. is better than the best class I have ever had
   B. is definitely better than the average class
   C. is about the same as other classes I've had
   D. isn't as good as most classes I've had
   E. is among the worst classes I've had

4. Would you prefer to take this class using a different method of instruction?

   A. Yes, definitely
   B. Yes, I think so
   C. I don't know
   D. No, I don't think so
   E. No, definitely

5. Are you able to understand your textbook, workbook and reference material?

   A. Yes, easily
   B. Yes
   C. Does not apply to this class
   D. No
   E. No, not at all

6. Are you able to understand your learning/lab activities?

   A. Yes, easily
   B. Yes
   C. Does not apply to this class
   D. No
   E. No, not at all

7. Do you study the material for this class outside of your regularly scheduled class time?

   A. Yes, usually more than one hour per day
   B. Yes, usually up to one hour per day
   C. Yes, but only sometimes
   D. No, rarely
   E. No, never. I do all of my work in class.

8. If for some reason you miss this class, will you have work to make up?

   A. Yes, always
   B. Yes, sometimes
   C. I don't know
   D. No, rarely
   E. No, never

9. How interested were you in the occupation for which you are now training when you entered this program?

   A. Very interested; it's what I wanted to do for a living
   B. Interested; I thought I would like it more than most things I've tried
   C. Mildly interested; I thought it would be O.K.
   D. Slightly interested; there were othere things I would rather have been learning
   E. Not interested at all

10. Now that you have studied for this occupational area, how interested are you?

   A. Very interested; it's what I want to do for a living
   B. Interested; I think I like it more than most things I've tried
   C. Mildly interested; I think it will be O.K.
   D. Slightly interested; there are other things I would rather be learning
   E. Not interested at all

11. Is the method of instruction used in this class fair to and honest with the students?

   A. Yes, definitely
   B. Yes, most of the time
   C. I don't know
   D. No, not much of the time
   E. No, definitely

12. The following best describes your instructor's availability:

   A. Excellent; he is always available when I need him
   B. Good; he is usually available when I need him
   C. Fair; he is available only some of the times I need him
   D. Poor; he is rarely available when I need him
   E. Very poor; he is never available when I need him

13. Is the material for this class well prepared and organized?

   A. Yes, always
   B. Yes, usually
   C. I don't know
   D. No, seldom
   E. No, never

14. Is the material for this class presented clearly?

   A. Yes, definitely
   B. Yes, for the most part
   C. I don't know
   D. No, the presentations are a little confusing
   E. No, the presentations are very confusing

15. To what degree does your instructor give you personal attention and individual help?

    A. He gives all the attention and help I need
    B. He gives most of the attention and help I need
    C. He gives me some attention and help
    D. He rarely gives enough attention and help
    E. He never gives any personal attention and help

16. Do you enjoy the method of instruction used in this class?

    A. Yes, definitely
    B. Yes, generally
    C. It's O.K.
    D. Not very much
    E. No, definitely

17. The facilities and equipment used in this class are:

    A. Excellent
    B. Good
    C. Fair
    D. Poor
    E. Very poor

18. How important do you feel this particular class was to your eventual career goal?

    A. Very important; I feel this class was a necessary part of my education
    B. Important; I feel this class will help me in my career
    C. I don't know
    D. Not very important; I don't think it will prove to be of much value in my career
    E. Unimportant; I feel the class was a waste of time and will be of no value to me in my career

19. Do you feel that you have mastered the material contained in this class?

    A. Yes, definitely
    B. Yes, to some degree
    C. I don't know
    D. No, not to the degree that I would have liked
    E. No, definitely

20. Were the goals and objectives of this course clearly defined at the beginning?

    A. Yes, definitely
    B. Yes, to some degree
    C. I don't know
    D. No, the goals and objectives were somewhat unclear from the beginning
    E. No, definitely

21. At this point in time do you feel prepared and confident enough to go out in the field and perform the job for which you were trained?

    A. Yes, definitely
    B. Yes, for the most part
    C. I don't know
    D. No; I feel that I need more training in this field before I could perform well at a job
    E. No; I feel very unprepared and lack the confidence I need to perform at a job in the field

22. Knowing what you know now, if you had a chance to go back in time would you re-enroll in your present program of study?

    A. Yes, definitely
    B. Probably
    C. I don't know
    D. Unlikely
    E. No, definitely

23. Would you recommend this program of study to a good friend?

    A. Yes, definitely
    B. Probably
    C. I don't know
    D. Unlikely
    E. No, definitely

4. Knowing what you know now, if you had a chance to go back in time would you re-enroll at Kirkwood?

    A. Yes, definitely
    B. Probably
    C. I don't know
    D. Unlikely
    E. No, definitely

25. If you answered Question #24 with a D or an E, what changes in Kirkwood would change your answer to an A or B?

26. If and when you must make up work for a class that you have missed, in what manner do you make up the work? (For example, extra class time, written work, etc.)

27. List any changes you think would improve the method of instruction used in this class.

28. List the strong points regarding the method of instruction currently used in this class.

ENTRY (PRE-TEST) TO BASIC MATH MODULE

Module No:	**Module Title:** Basic Mathematics
Approx. Time: ½ hour	**Submodule Title:** Statistics
	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 4 out of 5 problems related to:

1. Arithmetic Mean
2. Median

1. Find the arithmetic mean to 50, 38, 32, 45, 55, 62, 48, 31

   a. 42

   b. 45.1

   c. 48

   d. 31

2. Find the median to 38, 45, 55, 62, 31, 32, 68, 42, 39

   a. 46.5

   b. 31

   c. 45.1

   d. 42

3. Find the arithmetic mean to 2200, 2061, 2145, 2182, 2021, 2089, 2074

   a. 2110.3

   b. 2081.5

   c. 2089

   d. 2074

4. Find the median of 2.9, 4.8, 4.9, 5.3, 5.6, 5.4, 6.2, 2.6
   - a. 4.9
   - b. 5.3
   - c. 5.1
   - d. 4.7

5. Find the arithmetic mean to 60, 62, 60, 60, 60, 58, 61, 62, 63.5
   - a. 47.4
   - b. 63.5
   - c. 60.7
   - d. 60.0

Module No:	**Module Title:** Basic Mathematics
Approx. Time: ½ hour	**Submodule Title:** Powers and Roots
	EVALUATION

Objectives:

The learner will demonstrate the ability to calculate correctly the answers to 4 out of 5 problems related to powers and roots of numbers.

1. The square root of 15625 is
   a. 225
   b. 7812.5
   c. 5208.3
   d. 125

2. The cube root of 1953125 is
   a. 125
   b. 651041.66
   c. 5
   d. 15625

3. The formula of the volume of a cube is $(L)^3$. If $L = 25$ ft. what is the volume.
   a. 15625 cubic feet
   b. 75 cubic feet
   c. 1953125 cubic feet
   d. 625 cubic feet

4. A formula is $A = 3.14 \times R^2$. If R is 50 ft. calculate for A
   a. 314 sq. ft.
   b. 7850 sq. ft.
   c. 157 sq. ft.
   d. 22.2 sq. ft.

5. What is the cube of 65.

   a. 4.02

   b. 195

   c. 390

   d. 274625

Module No:	Module Title: Basic Mathematics
Approx. Time: ½ hour	Submodule Title: Percent
	EVALUATION

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 4 out of 6 problems involving percent and percent efficiency (percent removal).

1. 400/700
   - a. 17.5
   - b. 57.14
   - c. 5.354

2. What is the % removal of settleable solids in a primary treatment system if the influent is 18 ml/1000 ml and effluent is 2 ml/1000 ml.
   - a. 8.889
   - b. 11.1
   - c. 111.1
   - d. 88.89

3. Calculate the % removal of BOD if the influent is 189 mg/l and the effluent is 15 mg/l.
   - a. 92.06
   - b. 7.936
   - c. 9.206
   - d. 79.36

4. A plant has an influent of 110 mg/l of solids. The effluent has a concentration of 3.8 mg/l. Calculate the % removal.
   - a. 3.455
   - b. 96.55
   - c. 34.55
   - d. 9.655

5. What is the percent removal of ammonia if the influent has a concentration of 62 mg/l and the effluent has a concentration of 16 mg/l.

   a. 74.19

   b. 2.580

   c. 7.419

   d. 25.80

6. The influent of a plant has a concentration of 218 mg/l of BOD. After primary treatment the BOD is reduced to 150 mg/l. After secondary treatment the BOD is discharged at 21 mg/l concentration. Calculate the efficiency of the plant.

   a. 86.00

   b. 90.37

   c. 31.19

   d. 9.633

Module No:	**Module Title:** Basic Mathematics
	Submodule Title: Detention Time
Approx. Time: 1 hour	**EVALUATION**

Objectives:

The learner will demonstrate the ability to determine correctly the answers to 8 out of 10 problems related to detention time in water and wastewater units.

1. A plant has a rectangular grit chamber. The dimensions of the tank are 20 ft. length, 5 ft. width and 3 ft. depth. The flow 57.2 MGD. Calculate the detention time in seconds.

   a. 32.08 sec.

   b. 41.67 sec.

   c. 3.39 sec.

   d. 8.54 sec.

2. What is the detention time in a clarifier if the flow rate is 3.8 MGD and the radius of the tank is 30 ft. and the height is 15 ft.

   a. 4 hrs.

   b. 11.98 hrs.

   c. 0.5 hrs.

   d. 2 hrs.

3. A lagoon with an average length of 475 feet and average width of 350 feet has a depth of 4 feet. What is the average detention time if the average daily flow rate is 55,690 gallons.

   a. 89.32 days

   b. 11.94 days

   c. 44.66 days

   d. 62.45 days

4. A tank 65 ft. in diameter, 8.5 ft. deep receives a flow of 300 GPM. What is the detention time.

   a. 2.0 hrs.

   b. 11.7 hrs.

   c. 6 hrs.

   d. 46.86 hrs.

5. In a water treatment plant a settling tank 70 ft. in diameter, 8.5 feet deep receives a flow of 2,320 GPM. Calculate the time.

   a. 42.6 min.

   b. 14.1 min.

   c. 77.4 min.

   d. 105.4 min.

6. In a conventional activated sludge plant the aeration basin has the dimensions of 60 ft. long, 20 ft. wide, 15 ft. deep. The flow to the basin is 281 GPM. What is the detention time in the aeration basin.

   a. 16 hrs.

   b. 6.3 hrs.

   c. 1.06 hrs.

   d. 8 hrs.

7. In problem 6 if you increase the flow by 25% what is the new detention time.

   a. 1 hr.

   b. 6.4 hrs.

   c. 2.8 hrs.

   d. 8 hrs.

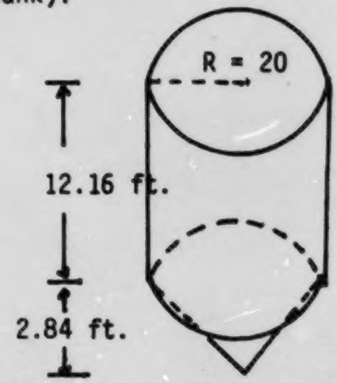
8. Calculate the detention time of a settling basin that receives a flow of 1.05 MGD. (See sketch for dimensions of tank).

   a. 2.6 hrs.

   b. 3.2 hrs.

   c. 2.8 hrs.

   d. 1.8 hrs.



9. A 2-cell lagoon operating in series. Cell one has the dimensions of surface length 500 ft., surface width 400 ft., bottom length 475, bottom width 385. Cell two has a surface length of 600 ft. and surface width of 300 feet, bottom length of 580, and bottom width of 290. Both lagoons operate at a depth of 5 ft. What is the average detention time if the average daily flow is 303,800 gallons.

   a. 12.00 days

   b. 45.00 days

   c. 90.00 days

   d. 60.00 days

10. A chlorine contact chamber has the dimensions of 5 ft. x 5 ft. x 5 ft. If the flow through the chamber is 2.8 MGD what is the detention time.

   a. 6.0 sec.

   b. 44.6 sec.

   c. 28.8 sec.

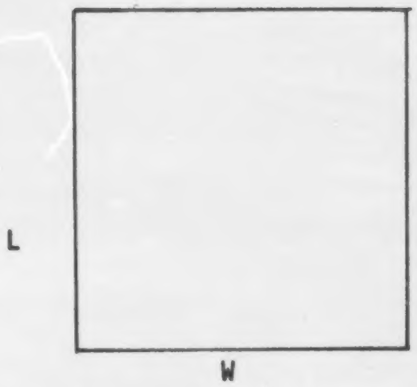
   d. 18.9 sec.

AREAS

1. **Square**

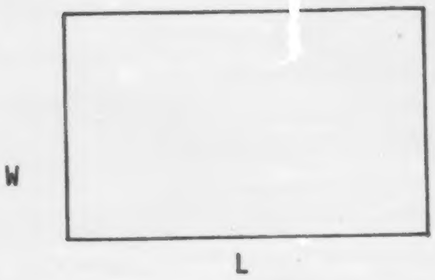
$A = L \times W$

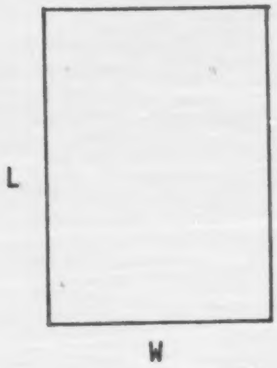
L - W



2. **Rectangle**

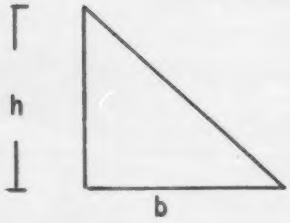
$A = L \times W$

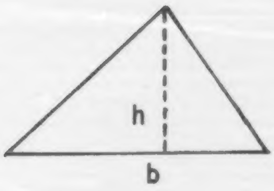


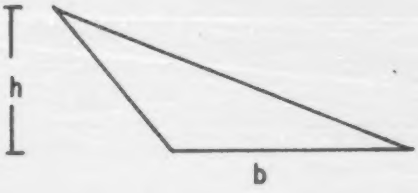


3. **Triangle**

$A = \frac{1}{2} b \times h$







4. **Circle**

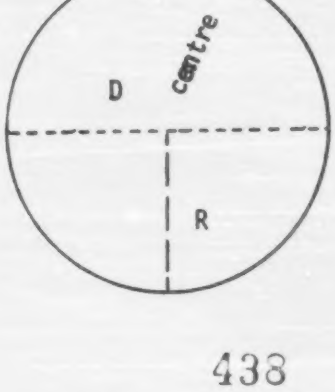
$A = \pi R^2$

or

$A = \frac{\pi D^2}{4}$

or

$A = .785 \times D^2$

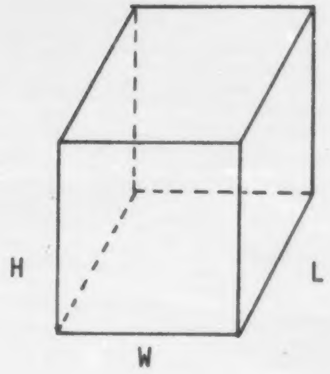


VOLUMES

1. **Cube**

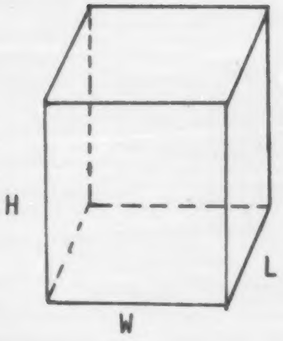
$V = L \times W \times H$

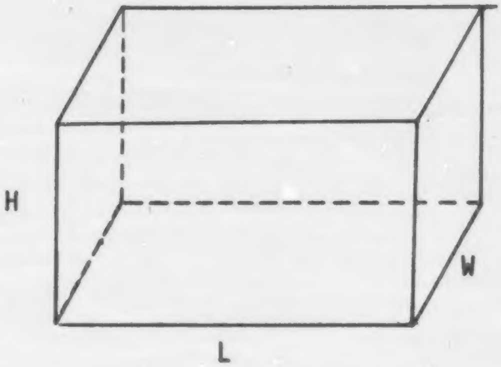
$L = W = H$



2. **Rectangular Solid**

$L \times W \times H$



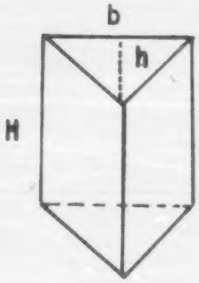


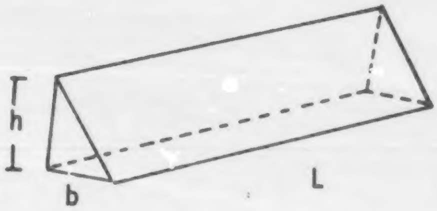
3. **Prism**

$V = \frac{1}{2} b \times h \times H$

or

$V = \frac{1}{2} b \times h \times L$





4. **Cylinder**

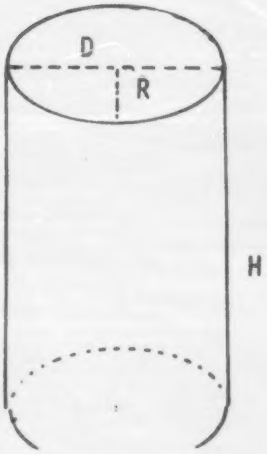
$V = \pi \times R^2 \times H$

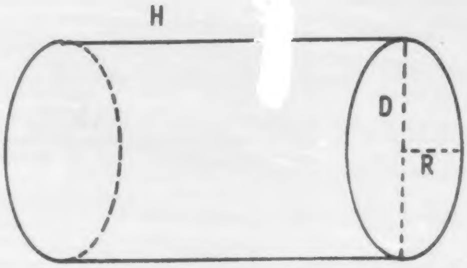
or

$V = \frac{\pi}{4} \times D^2 \times H$

or

$V = .785 \times D^2 \times H$





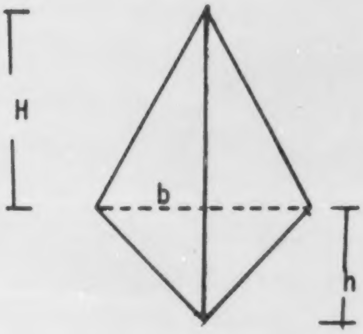
VOLUMES

5. **Sphere**

$V = \frac{4}{3} \times \pi \times R^3$

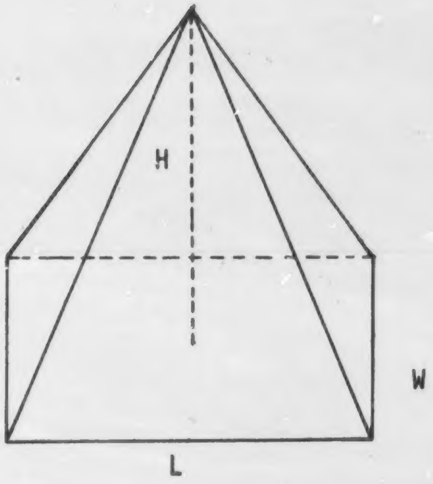
6. **Pyramid** (triangular base)

$V = 1/6 \times b \times h \times H$



7. **Pyramid** (rectangular base)

$V = \frac{1}{3} \times L \times W \times H$



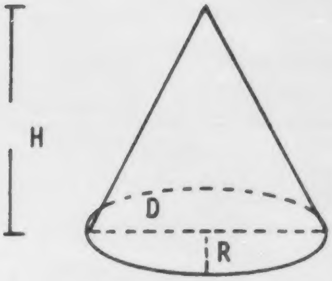
8. **Cone**

$V = \frac{\pi \times R^2 \times H}{3}$

or

$V = \frac{\pi \times D^2}{12} \times H$

or



PAD

(Personal Achievement Department)

Diagnostic Program

Math

Reading

Testing

THE PERSONAL ACHIEVEMENT DEPARTMENT

Diagnostic services are provided for water/wastewater technology students at Kirkwood Community College in mathematics and reading through the PAD (Personal Achievement Department). Water/wastewater technology students are referred to PAD for remedial services by instructors from the department, counselor, or self-referral. The student begins the PAD program by going through diagnostic assessment, establishing a plan of study and maintaining a personal progress chart. Students develop specific skills in math and reading through commercially produced learning packets produced by a variety of companies. Also a number of vocabulary programs are produced by faculty members. Diagnostic followup and progress summary is done once the student establishes proficiency in the area(s) of math or reading in which they were deficient. Students receive up to 3 hours of credit for successful completion of a personal achievement unit. Approximately 30% of the water/wastewater students participated in the PAD program in 1976-77 quarters.

PAD provides skills development in the areas of mathematical, writing, punctuation, grammar, study skills, and reading to all Kirkwood students according to the availability of counselors.

The following are descriptions of the personal achievement department's programs.

Personal Achievement Math

Personal Achievement Math is a one to three credit hour course covering basic mathematical skills (see outline below). At the beginning of the quarter the students will take a ciagnostic test. The California Achievement Test and the College Entrance Examination Board test. Using the results of the tests, an individualized program is developed to improve the skill level of the student.

Materials:

Numbers and Operations by Lankford, Heikkinen, and Silvey

Basic Mathematics for College Students by Edwin Stein

A First Program in Mathematics by A. Heywood

Mathematics for Individual Achievement by Penholm, Hankins, Herrick, and Vojtko as revised and compiled by Betty Baenziger

Educulture Tutorial Systems: Basic Applied Mathematics Mini-Course

Course Outline

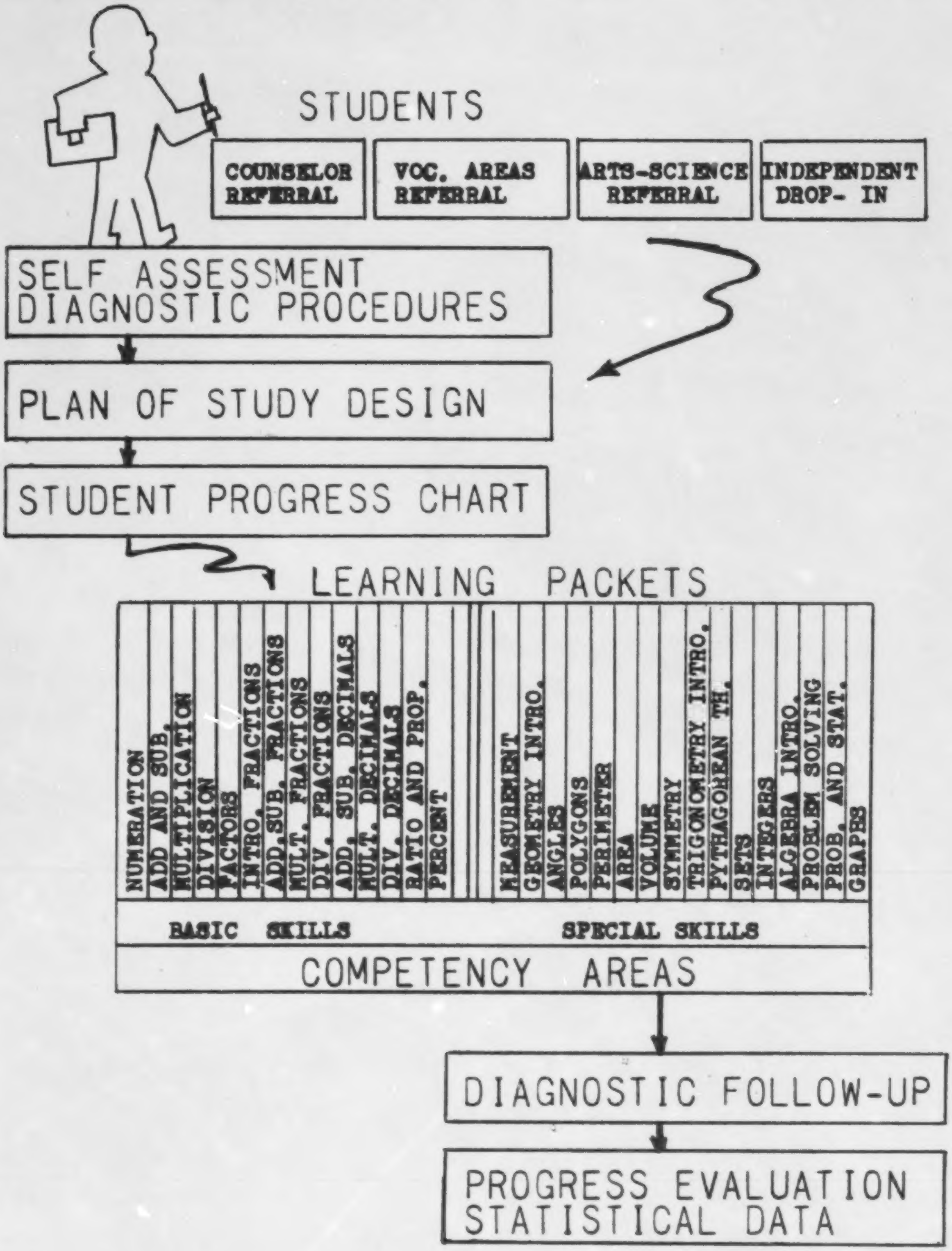
Course Goal: To provide the student with mathematical skills, so she/he can meet with success in math related course work.

I. Principal Areas of Study
    A. Addition and Subtraction of Whole Numbers
    B. Multiplication and Division of Whole Numbers
    C. Addition and Subtraction of Common Fractions
    D. Multiplication and Division of Common Fractions
    E. Fractions and Decimals
    F. Addition and Subtraction of Decimals
    G. Multiplication and Division of Decimals
    H. Ratio and Proportion
    I. Percents

II. Supplementary Areas of Study

- A. Proglem Solving Techniques
- B. Measurement - English and Metric
- C. Geometry - Areas, Volumes, Perimeters, etc.
- D. Graphs, Charts, Tables, Diagrams
- E. Problem Solving Applied to Content Area

DEVELOPMENTAL MATH.



STUDENTS

COUNSELOR REFERRAL

VOC. AREAS REFERRAL

ARTS-SCIENCE REFERRAL

INDEPENDENT DROP- IN

SELF ASSESSMENT
DIAGNOSTIC PROCEDURES

PLAN OF STUDY DESIGN

STUDENT PROGRESS CHART

LEARNING PACKETS

NUMERATION
ADD AND SUB.
MULTIPLICATION
DIVISION
FACTORS
INTRO. FRACTIONS
ADD.SUB. FRACTIONS
MULT. FRACTIONS
DIV. FRACTIONS
ADD. SUB. DECIMALS
MULT. DECIMALS
DIV. DECIMALS
RATIO AND PROP.
PERCENT

MEASUREMENT
GEOMETRY INTRO.
ANGLES
POLYGONS
PERIMETER
AREA
VOLUME
SYMMETRY
TRIGONOMETRY INTRO.
PYTHAGOREAN TH.
SETS
INTEGERS
ALGEBRA INTRO.
PROBLEM SOLVING
PROB. AND STAT.
GRAPHS

BASIC SKILLS

SPECIAL SKILLS

COMPETENCY AREAS

DIAGNOSTIC FOLLOW-UP

PROGRESS EVALUATION
STATISTICAL DATA

DIAGNOSTIC ANALYSIS SHEET*

Student's name ______________________________ Date tested ______________

Examiner ______________________________________

Item break-down - Circle items missed

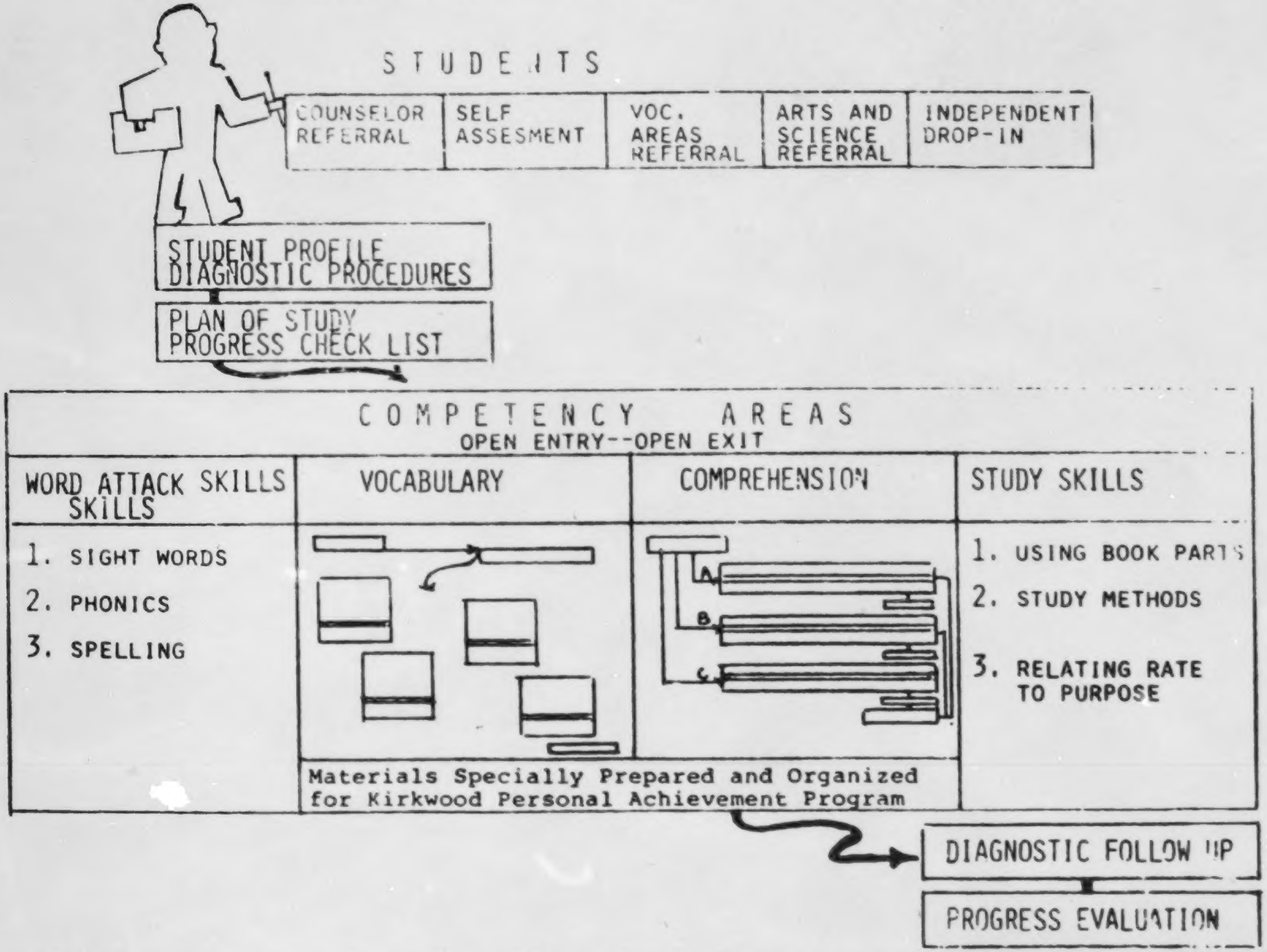
Vocabulary:	
Use of context -	2 7 10 11 14 16 17 21 22 25 27 28 33
Figurative language -	32 35
Recall:	
Identification of detail and facts -	3 5 18 19 24 26 30 31
Interpretation:	
General inference -	4 6 12 15 20 29 34
Identification of main idea -	1 8 13
Author's point of view -	9
Cause and effect -	23

Was the test completed in twenty (20) minutes? Yes No

TESTS

CALL #	TITLE	AUTHOR/PUBLISHER	SPECIAL NOTATION	# OF COPIE
	Vocabulary & Comprehension	IPMS Houghton-Mifflin		
428.4 139D	IRS Pretests Level A	Houghton Mifflin		1
	IRS Pretests Level B	Houghton-Mifflin		1
	Teacher-made Pre-Diagnostic test			100
	Health Occupations Packets Pre and Post Tests			50
	Environmental Health Packets Pre and Post Tests			50
	Auto Repair Packets Pre and Post Tests			50
	Osgood Measure of Attitude			200
	Evaluation of Learning Packets			100

DEVELOPMENTAL READING



STUDENTS

- COUNSELOR REFERRAL
- SELF ASSESMENT
- VOC. AREAS REFERRAL
- ARTS AND SCIENCE REFERRAL
- INDEPENDENT DROP-IN

STUDENT PROFILE
DIAGNOSTIC PROCEDURES

PLAN OF STUDY
PROGRESS CHECK LIST

COMPETENCY AREAS
OPEN ENTRY--OPEN EXIT

WORD ATTACK SKILLS SKILLS	VOCABULARY	COMPREHENSION	STUDY SKILLS
1. SIGHT WORDS 2. PHONICS 3. SPELLING	Materials Specially Prepared and Organized for Kirkwood Personal Achievement Program		1. USING BOOK PARTS 2. STUDY METHODS 3. RELATING RATE TO PURPOSE

DIAGNOSTIC FOLLOW UP

PROGRESS EVALUATION

SEQUENCE OF WORD ANALYSIS AND SPELLING SKILLS IN DEVELOPMENTAL READING

Phonic Analysis	Structural Analysis	Spelling Skills
Single consonants		Initial and final consonants
Initial consonant substitution Consonant digraphs Consonant blends	Compound words	Initial, final digraphs Initial, final blends
Short vowels in CVC monosylables		Short vowels in CVC, then CCVCC words
		CVC words ending in ff, ll, ss, ck
Sounds of common inflectional endings	Inflection of CVC words: Endings: s, es, ing, ed, er, est, y, ly	Forming plurals Double final consonant of CVC words before endings beginning with a vowel
	Contractions	
	Syllabication, 2-syllable words: 1.Divide between root words and endings 2.Divide between like consonants 3.Divide between unlike consonants	
Sound of consonant-le	4.Divide before consonant-le (/Cle)	Spell consonant-le words
Long vowels: 1.In the CVCɆ pattern		Spell CVCɆ words
2.At the end of monosyllables and open syllables	5.Divide CVC/V or CV/CV	Drop the Ɇ in CVCɆ before endings beginning with a vowel
3.In ild and old families and other exceptions to CVC.	6.Common syllables: ly, ful, less, en, ness, ment, re, in, per, pre, tion, etc.	
r-controlled vowels: er, or, ir, ar, ur Vowel combinations: ia; ai, ay; ee, oi, oy; ou, ow; oo; ey; au, aw; ea; ie	Syllabication of polysyllabic words: Common roots Common affixes Vowel alternation Vowel reduction	

TESTS

CALL #	TITLE	AUTHOR/PUBLISHER	SPECIAL NOTATION	# OF COPIES
	Vocabulary & Comprehension	IPMS Houghton-Mifflin		
428.4 1390	IRS Pretests Level A	Houghton Mifflin		1
	IRS Pretests Level B	Houghton-Mifflin		1
	Teacher-made Pre-Diagnostic test			100
	Health Occupations Packets Pre and Post Tests			50
	Environmental Health Packets Pre and Post Tests			50
	Auto Repair Packets Pre and Post Tests			50
	Osgood Measure of Attitude			200
	Evaluation of Learning Packets			100

STUDY SKILLS

CALL #	TITLE	AUTHOR/PUBLISHER	SPECIAL NOTATIONS	# OF COPIES
	SRA Reading Accelerator		Machine	1
	Student LRC Handbook		Consumable	5
	Practice in Library Skills		Consumable	
371.302 S933	Study Skills Library Orientation Lesson	EDL		1 box
371.302 S933SF	Science F			1 box
371.302 S933SI	Science H			1 box
371.302 S933RI	Reference III			1 box
371.302 S933RE	Reference EEE			1 box
	Reference Sheets			39
	Practice in Dictionary Skills		Consumable	
	Key for Practice in Dictionary Skills			
	How To Mark a Book Worksheets		Consumable	5
428.4 S735N	The Now Student	Jamestown Publishers		
	Answering True-False Questions Worksheets		Consumable	35
TCA 77-008 - 77-019	Reading Development& Study Skills Program	Sack/Yourman	3 Workbooks 12 Tapes	→
	Notetaking Lecture Practice Tape		1 tape	→
428.43 S978C	College Reading & Self Help			

DECODING SKILLS

CALL #	TITLE	AUTHOR/PUBLISHER	SPECIAL NOTATION	# OF COPIES
	Teacher-made sight word cards			
	Teacher-made work sheets			
	Letter Sound Worksheets	New Readers Press	Consumable	
	Building Word Power	Adams		1
	From A to Z	Steck-Vaughn		1
	Individualized Reading Skills Program - Levels A and B	Houghton-Mifflin	Kits	2
	The Mature Students' Guide to Reading & Comprehension	Lipscomb		1
	Working With Words	Putnam		1
	Working With Patterns			1

COMPREHENSION

COMPREHENSION

CALL #	TITLE	AUTHOR/PUBLISHER	SPECIAL NOTATION	# OF CPS.
	Reading Essentials Series	Leavell/Gardner - Steck Vaughn	Series	
	Avenues to Explore			1
	Challenges to Meet			1
	Discoveries to Make			1
	Horizons to See			1
	Pathways to Build			1
	Steps to Take			1
	Comprehension Skills Series	Giroux&Williston - Jamestown	Series:Books&Tapes	
TCA77001	Understanding the Main Idea	" " "		1 & 1
TCA77002	Making a Judgement	" " "		" " "
TCA77003	Drawing a Conclusion	" " "		" " "
TCA77004	Making an Inference	" " "		" " "
TCA77005	Retaining Concepts and Organizing Facts	" " "		" " "
TCA77006	Isolating Details and Recalling Specific Facts	" " "		" " "
	Understanding the Main Idea	" " "	(Middle Level)	1 & 0
428.4 T 5475	SRA Reading for Understanding		Kit	1
	Timed Reading Level 1	Spargo/Jamestown Publish.		1
	Timed Reading Level 8	" " "		1
	Reading Drills	Fry/Jamestown Publishers		1
	Efficient Reading	Brown/Heath & Co. Pub.		1
808.042 L767C C.2	Communications . . . A Guide to Comprehension and Reading	Lipscomb		1
428.4 D2720	Developing Comprehension Including Critical Reading	Dawson		1
	Read the Instructions First	Greatsinger		1
	Family Development Series	Steck Vaughn Company	Series	
	Buying Guides			1
	Health, Safety, & Sanitation			1
	Becoming a More Effective Person			1
	Family Money Management			1
	Communicating With Others			1

COMPREHENSION

C[illegible] #	TITLE	AUTHOR/PUBLISHER	SPECIAL NOTE	# OF CPS
3[illegible].4 L3[illegible]	Everyday Reading & Writing	Laubach		1
	Teacher-Made Comprehension Kits			
	How To Read & Write Business Letters			1
	How To Read & Write Personal Letters			1
	How To Read Personal Business Papers			1
	How To Read Newspapers			1
	How To Use Telephones			1
	Instructions on Safety		Pamphlet	1
	Literary Materials	Gearing		2
42[illegible].4 P2[illegible]8S	SRA Reading Laboratory IVa		Kit	1
42[illegible].4 P2[illegible]C	SRA Reading Laboratory IIIa		Kit	1
	Steps to Learning 1	Steck-Vaughn		1
	Steps to Learning 2	Steck-Vaughn		1

19[illegible]5-76 report

PERSONAL ACHIEVEMENT - READING

TASK	ACCOMPLISHMENTS TO DATE
1. Determine the reading skill level necessary to successfully complete materials currently used in the three career clusters-- Medical Assistant Environmental Health Auto Collision Repair	1. Determining Reading Skill Levels a. The General Motors STAR readability test was run on three samples from each textbook of the three career programs. Results of this test indicate the approximate grade level equivalencies of materials used. While selections ranged from the 8th grade to the 18th grade levels, much of the reading material fell above the 13th grade level. (Sample included in 6 month report, January, 1976) b. As a follow-up of this computer-run readability test, an in-service session was held with not only Group A instructors, but also all Trade and Industry instructors. Shorter and quicker means of determining readability (the Fry Graph and the Cloze Test) that the instructors themselves can apply were demonstrated. c. After it was determined to base the developmental curriculum on reading competencies, the Reading Specialist conducted a Reading Skills Survey with each of the programs in Group A. The purpose of this survey was to assess the specific reading skills necessary to successfully enter and complete each of the programs.
2. Develop a testing program to determine reading skills of students in each of the same career clusters.	2. Testing Program a. The Nelson-Denny Standardized Reading Test was administered to students presently enrolled in each of the three career programs. b. The Individual Pupil Monitoring System (Houghton-Mifflin) is presently being used

		MODIFICATION FROM ORIGINAL OBJECTIVES
	to assess student strengths and weaknesses on specific skills. c. In addition to the standardized tests, an informal reading inventory has been developed fro each of the programs in Group A. (See Appendix 1)	Although the grant refers to reading levels, a student's"grade level" on a standardized test (such as the Nelson-Denny) only indicates a summary average of the student's reading ability. On the other hand, the hypothesis is that determining specific reading competencies the students already have and which they need to develop will more efficiently expedite the student's improvement. Also, it is hoped that breaking the reading process down into units for the student will in itself clarify that process.
3. Design a developmental program curriculum in the area of reading, relating the subject matter content directly to the vocational choice of the student.	3. Reading Curriculum a. An overall plan for entry into and exit from the developmental lab as well as procedure for entry-exit within the reading curriculum has been developed. (See Appendix 2) (1) The "reading process" was outlined in a competency-based format. Competencies have been identified for each reading skill under the three main categories of vocabulary, comprehension, and study skills. (See Appendix 3) b. A multi-level variable entry-exit reading curriculum is partially completed for Group A programs. (1) Vocabulary Learning packets have been developed for each of the vocabulary competencies with contents related to each of the three vocational career clusters of Health	

Occupations, Auto Repair, and Environmental Health. (See sample packets and Appendix 4)

(a) Each packet contains:
--specific learning objectives
--instructional guides (strategy for how to perform the skill)
--learning activities
--self post tests

(b) Final post tests for each of the objectives of the vocabulary packets have been written, color-coded by vocational program and assembled for student and instructor use.

(2) Comprehension

(a) Commercial materials such as the Houghton-Mifflin "Individualized Reading Skills" modules and Jamestown Publisher's audio tapes will be used as instructional guides for the comprehension competencies.

(b) Specific content-related learning activity materials have been compiled to be used in conjunction with the instructional guide modules. Students will have the opportunity to practice specific comprehension skills on compiled materials that are directly related to their vocational program or personal interests. (See Appendix 5)

Within each interest area, the materials are multi-level in that they are categorized into 3 levels of difficulty, based on sentence length and syllable count ("Fry Readability method).

Level A = easy (6th - 8th grade reading level)
Level B = average (9th - 10th grade reading level)
Level C = more difficult (11th - 12th grade reading level)

This categorization provides the students with (1) material at their level and interest and (2) the opportunity to progress from easy to more difficult reading.

The compiled materials include pamphlets, booklets, charts, journal and newspaper articles, job sheets, textbook exerpts, maps, manuals, parts catalogues, etc. These materials were obtained free or at minimal cost through sources listed below:

1. Free Materials for Classroom Teachers; Aubrey, Ruth H., (Fearon Publishers, Inc., Belmont, California) 1975

2. Elementary Teacher's Guide to Free Curriculum Materials; Patricia H. Suttles, editor; (Educators Progrss Service, Randolph, Wisconsin) 1975

3. Government publications such as Consumer Information (Index of Selected Federal Publications of Consumer Interest), National Bureau of Standards Publications, Department of Health, Education, and Welfare, Department of Agriculture and others.

4. Vertical File Index: A Subject and Title Index to Selected Pamphlet Materials, H.W. Wilson Company

5. Group A program instructors contributed advertisements, job circulars, brochures, and duplicate manuals, etc.

EVALUATION

As stated in the original grant, "no formal evaluation of the Developmental Program will occur during the first year". However, already developed sample packets are being used with some students presently enrolled in the developmental lab for preliminary evaluation of clarity of instructions. Also, periodic information and updating reports have been presented to (1) Kirkwood department chairpersons and (2) the internal project advisory committee.

SPOT

I. Course Content, Objectives, and Structure

101. Course difficulty was appropriate for my background.

102. Course organization assisted me in learning.

103. Subject matter was intellectually stimulating to me.

104. Course content was interesting to me.

108. Course goals were clear to me.

111. I learned basic terms in this area.

112. Objectives encouraged me to learn the structure and methodology of the subject.

114. I was encouraged to apply knowledge and skills in new situations.

115. Course objectives helped me understand main emphases.

116. I was encouraged to learn on my own.

117. Course requirements were clear from the beginning.

122. Facts and concepts from related fields were presented.

123. Instructor emphasized ways of solving problems rather than solutions.

124. Practical applications of the material were discussed.

127. Adequate time for questions was provided.

128. Instructor emphasized ideas rather than facts.

129. Rational and intellectual aspects of the subject were stressed.

130. General concepts and ideas were stressed.

131. The course required an appropriate amount of work for the credit earned.

132. Course objectives helped me organize my studying.

133. The pace of the course met my needs.

134. Course objectives represented outcomes which I could achieve in the time allotted.

135. Course objectives were adequately detailed to aid my learning.

136. Scheduled class time was used efficiently.

137. Course content clarified techniques I was expected to develop.

138. Prerequisite course work adequately prepared me to handle assignments in this course.

II. Instructor's Behavior

201. Concepts were presented in a manner that aided my learning.

203. My work was evaluated in ways that were meaningful to me.

206. Instructor seemed aware of my needs, abilities, and interests.

207. Instructor seemed to be concerned with whether I learned the material.

208. Instructor seemed enthusiastic when presenting course material.

209. Instructor seemed interested in teaching this course.

210. Instructor responded to my questions with clarity.

211. Discussions raised interesting new ideas.

212. My questions were answered fully and completely.

214. Instructor was available to me outside of class.

215. Difficult concepts were explained in a helpful way.

216. Instructor gave sufficient detail to make generalizations meaningful to me.

217. Instructor spoke clearly and was easily understood.

218. Presentations were interesting and challenging.

219. Material was summarized in a manner which aided my retention.

221. Instructor communicated at a level appropriate to my understanding.

226. Instructor summarized major points.

228. Instructor made clear what he/she considered important.

233. Instructor invited criticisms of his/her own ideas.

234. I was encouraged to participate in class discussion.

239. Instructor encouraged students to see him/her if they were having difficulty.

241. Instructor discussed points of view other than his/her own.

242. Recent developments in the field were discussed.

245. Class presentation seemed well organized.

247. Well-chosen examples were used to clarify points.

249. I was encouraged to participate in class critiques.

250. When the instructor sensed the class was confused, attempts were made to clear it up.

251. My work was evaluated in ways that were helpful to me.

252. Instructor treated me as an individual.

253. Views of pertinent authorities were discussed.

254. Instructors were in agreement on their evaluations of my work.

255. Instructor helped me improve my technique.

256. Instructor identified specific problems with my technique.

257. Instructor critiqued by work/performance without embarrassing me in front of classmates.

258. Instructor's handling of this class illustrated guidelines for ethical professional behavior.

259. Instructor provided me with techniques and information necessary for understanding course material.

260. Instructor helped me to improve my writing skills.

261. Instructor focused discussions to raise interesting new ideas.

III. Instructional Methods and Materials

301. Grades were based on a fair balance of requirements and content.

303. I knew what improvement was needed from feedback on tests/assignments.

304. Exams reflected the emphases of class presentations.

305. Exams allowed me to adequately demonstrate what I learned.

306. Exams required me to do more than recall factual information.

309. Exams covered material on which I expected to be tested.

312. Exams stressed my ability to apply knowledge in new situations.

315. Assignments and expectations on homework were clear to me.

317. Assignments contributed to my learning.

318. Assignments were consistent with course objectives.

321. Assigned readings were pertinent to topics presented in class.

322. Course materials were a helpful guide to key concepts covered during class time.

326. Discussion was helpful to my learning.

329. Exams required creative, original thinking.

332. Exams required synthesis of various parts of the course.

333. Instructor had me apply concepts to demonstrate understanding.

334. Assignments and expectations on related work outside the class were clear to me.

335. Assignments were pertinent to topics presented in class.

336. The textbook was helpful for my understanding of this course.

337. Visual aids (overhead/slides/blackboard, etc.) contributed to my learning.

338. Grading criteria were clearly defined.

339. Oral presentations helped me develop my communication skills.

340. Lectures were consistent with the subject matter in the course outline.

341. Help was available to me outside of class if I had questions.

342. Visual aids (overhead/slides/blackboard, etc.) were clear and easily understood.

343. Required course activities involved more than simple recall of facts or cookbook procedures.

344. Required course activities aided my learning.

345. Required course activities were consistent with course objectives.

346. Grades were based on a fair weighing of the required course activities.

347. Required course activities provided a fair evaluation of my learning.

348. Assignments were well-spaced throughout the course.

349. Grades were an impartial assessment of my performance.

IV. Outcomes of Instruction

402. I became more interested in the subject.

403. I was stimulated to elect more courses in this area.

404. I was stimulated to do additional reading in the area.

405. I was stimulated to discuss new ideas in or out of class.

407. My knowledge and skills were increased.

408. I developed an appreciation for the subject.

409. My skill in critical thinking was increased.

410. My problem solving abilities were improved.

411. I learned fundamental principles or theories.

413. I learned to understand my strengths and weaknesses in the area.

414. Instructor helped me feel confident in expressing new ideas.

415. I learned to see relationships among important topics and ideas.

416. I was forced to think for myself.

417. I was motivated to do work beyond minimum requirements.

418. I was motivated to do my best work.

420. I was stimulated to substantial effort toward learning.

423. Instructor helped me integrate facts and develop generalizations.

424. I had an opportunity to demonstrate my knowledge and/or understanding.

425. I learned new ways to evaluate problems.

427. I learned how to find more information on the subject.

428. I was motivated to study a topic from the course on my own initiative.

429. I was stimulated to do additional work in the area.

430. My ability to critically analyze written material was improved.

431. I acquired a basic understanding of the subject area.

432. I developed a clear understanding of the moral and/or ethical issues in the areas.

433. My ability to integrate facts and develop generalizations was improved.

434. I learned more in this course than in most other college courses I have taken.

V. Laboratory Courses and Sections

501. Instructor was usually moving about the lab rather than stationary.

502. Instructor almost always spoke to me individually about the experiment in progress.

503. Instructor was able to explain how the apparatus should work.

504. Instructor was able to explain the procedures involved in the experiments.

505. Instructor appeared to understand the principles involved in the experiments.

506. Instructor usually managed to schedule lab time so I could finish the experiments.

507. Instructor rigidly enforced safety regulations (safety glasses, no eating in lab, etc.).

508. Instructor generally was able to answer my questions about what I should do next.

509. My lab reports were graded fairly and promptly.

510. I would recommend this lab instructor to a friend planning to take this course.

511. Instructor(s) identified SPECIFIC problems with my lab technique.

512. Instructor(s) demonstrated the lab techniques I was expected to develop.

513. Expectations about specific lab procedures were clearly stated in advance.

514. Appropriate and inappropriate lab behaviors were clearly identified.

515. Lab experiences clarified the lecture material.

516. Lab experiences will be helpful to me in my future profession.

517. Organization of the lab activities assisted me in learning.

518. I was able to complete the lab activities in the time allotted.

519. Lab experiences will be helpful to me in my future coursework.

520. Lab experiences assisted me in learning concepts.

VI. Clinical Courses

601. Instructor(s) identified SPECIFIC problems with my clinical technique.

602. Instructor(s) demonstrated the clinical techniques I was expected to develop.

603. Expectations about specific clinical procedures were clearly stated in advance.

604. Appropriate and inappropriate clinical behaviors were clearly identified.

605. Prescribed criteria were used in evaluating my performance.

606. Evaluations of my work by clinical faculty members were consistent.

607. Considering patient availability, required clinical experiences were realistic.

608. Instructor(s) embarrassed me in front of patients.

609. Instructor(s) frequently provided feedback on my performance which made me feel less self-confident.

610. Prior course work adequately prepared me to handle the clinical tasks.

611. Instructor(s) helped me correct problems in my clinical technique.

612. Performance exams allowed me to adequately demonstrate my clinical competencies.

613. An adequate amount of observation and supervision was provided.

614. Clinical experiences illustrated guidelines for ethical professional behavior.

615. I received constructive criticism of written reports.

616. Instructor(s) frequently provided feedback on the adequacy of my total performance.

617. Group meetings were helpful in increasing my knowledge and skills.

618. I was given responsibility for patients commensurate with my abilities.

619. I improved my ability to present and discuss case problems effectively and concisely.

620. I performed an adequate number of patient work-ups.

621. Some important topics could not be adequately covered because patients were unavailable.

VIA. Production Courses

631. The demands made upon my talents by this production were exciting and challenging.

632. I learned a substantial amount from being associated with this production.

633. The director's analysis of this production was made clear to me.

634. The director's concept and interpretation of this production were made clear to me.

635. The director helped me improve my performance in this production.

636. The director seemed interested in my role in this production.

637. The director was sensitive to my problems.

638. I would be eager to participate in another production under this director.

VII. Competency Based Instruction

701. Instructor helped me to improve my understanding of literature.

VIII. Telenet

801. The number of microphones were adequate for the group.

802. The equipment performed well a high percentage of the time.

803. The room used was conducive to learning.

804. It was easy to find parking near my class.

805. The class was scheduled at a good time for me.

806. The equipment was set up and working on arrival to class.

807. Printed materials arrived on time.

808. Operation of AV equipment at my site was handled adequately.

809. My class site was encouraged to participate in network discussions.

810. I would be eager to take another Telenet course.

WATER AND WASTEWATER
Advisory Committee

Jan. 11, 1978

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Department Head

ATTACHMENT 1.2

MINUTES

WATER AND WASTEWATER TECHNOLOGY
ADVISORY COMMITTEE
June 16, 1977

The Water and Wastewater Technology Program Advisory Committee met on Thursday afternoon, June 16, 1977. Those in attendance included George Milligan, Dave Millard, Marc Powell, Steve Jones, Eldon DeCamp. Kirkwood staff included Larry Willis, Harold Kort, Charlie Bardonner, Phil Koundakjian, Doug Feil, Cindy Root and Gary Feldman.

The Advisory Committee was updated on the Statewide upgrading workshops. They were shown maps which display the number of communities served during the years 1975 - 1976 and 1977 to date. The Circuit Rider Program was discussed and final results were shared with the committee. Some 110 unique towns were visited and about 35 re-visits were accomplished during that particular project. Discussion then focused on the one-year program and finally to the problem of recognition by the Iowa State Board of Operator Certification.

The committee was brought up to date on what has transpired since last fall when Messrs. Willis and Bardonner attended a public hearing on revised certification rules. They were also informed that on March 4, 1977, Mr. Bardonner was requested to furnish materials to the Board of Certification so that the program could be evaluated and its equivalence toward certification requirements determined. The materials were furnished to the Board on March 11, 1977. There was no action taken by the Board during the March and April meetings. Mr. Bardonner was invited to make an oral presentation to the Board during its May meeting at which time he requested that one-year Program completers be examined for the Grade II level of certification. The committee

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refused that proposal but did determine the one-year program completers would be allowed to take the Grade I examination. The committee offered several suggestions as to what course of action the department could well pursue in order to obtain some level of satisfaction from the Certification Board. These suggestions included meeting with Mr. Crane, the Director of the Iowa Department of Environmental Quality, Mr. Buckmeister, Chairman of the Water Quality Commission and contacting State Legislators. Plant superintendents hosting this year's water and wastewater program students for their internship should be requested to furnish written input on their judgment of the performance of the student relative to being prepared to perform as Grade II operators. Members of the committee were unanimously sympathetic to the problem and importance of appropriate recognition, expressed their concern, but thought action from Kirkwood staff would be most appropriate.

The Department Head assured the committee that he would keep them up to date on the situation and what action is taken. The Board of Certification will be meeting on June 20, in Des Moines. Messrs. Willis and Bardonner will attend this meeting at which time it is hoped the one-year program will be judged as to its credit toward Grade II certification.

Mr. Millard stated he would personally contact the chairman of the Board of Certification, Mr. Vernon Spilker.

The meeting was adjourned at 4 p.m. and members were shown the existing facility and its latest procurement, a water treatment unit which will be incorporated into the water portion of the program.

ATTACHMENT 1.2

MINUTES OF WATER AND WASTEWATER TECHNOLOGY

ADVISORY COMMITTEE MEETING OCT. 31, 1977

The meeting began promptly at 1:00 p.m. Several announcements were made relative to events since the last committee meeting:

1. Twelve students from 76-77 school year employed as plant operators (11 received diploma).
2. This year's program stands at 12 enrolled.
3. No change in certification status for one-year program completers.
4. The Department has received application forms and guidelines for receiving accreditation from the National American Water Works Association for the one-year program and for upgrading workshops conducted by the Department.

The agenda for the meeting included discussion of four significant issues. (Letter to Advisory Committee attached.)

I. Possibility of beginning a second section of the program in the Spring Quarter.

The Department Head raised this proposal for two reasons:

1. The good number of job opportunities that exist for water and wastewater plant operators and
2. The difficulty of recruiting students given only one starting date each year to begin the program.

Comments from the Advisory Committee generally reflected the concern that if the existing section is not filled to capacity (12 students in a class which could handle 21), it would be difficult to assume that simply opening another section in the Spring Quarter would result in a full class.

II. Possibility of altering the existing related instruction from exact courses to "approved electives". The Department Head distributed the one page brochure describing the course work required for each student enrolled in the program. He also explained the problems caused from the exactness of the course requirements due to the varying educational and experience backgrounds of the students who enroll in the program. This year's class includes students who attained high school completion through masters degreed students. The comments of the committee generally agreed with the concept of providing some flexibility.

III. Possibility of coupling the existing one-year program with additional management or science coursework leading to an associate of general studies degree as a program option. This was discussed as an option for the student enrolling in the program to attain a two-year degree. The two-year degree satisfies the existing educational requirements for the higher levels of certification as operators in the State of Iowa and offers the student interested in the program an opportunity to enroll at the beginning of any quarter of the school year.

Throughout the meeting the discussion of all items of the agenda included the impact of certification and the need to make the training accessible to not only new entry students, but people presently employed in the field.

The Committee recommended that the Iowa Board of Certification be invited to annually designate one of its members to sit on the Advisory Committee. The Committee felt the importance and impact of certification and the concern of the Committee merited this attempt at opening a direct line of communication, actually link, between the Committee and the Board of Certification.

The next meeting was targeted for early February 1978. At this next meeting the staff of the Water and Wastewater Technology will present alternatives for discussion by the Committee. The alternatives may address changes in required electives, modification of delivery to provide possibly an evening part-time schedule or other ideas presented by staff.

The meeting concluded with a period of introduction of students to Advisory Committee members and an informal question-discussion period within the total group.

Due to the length of the meeting, the election of a Chairman for the Committee was deferred until the next meeting. The list of attendees is attached.

mrm

OCT 31, 1977 ATTENDEES

1. Harry Boren
   Plant Superintendent
2. Ron Stellick
   Iowa DEQ
3. Steve Jones
   Iowa State University
4. George Milligan
   Plant Superintendent
5. Dan Johnson
   Private Industry
6. Andy Christensen
   Iowa Water Works Association
7. Dave Millard
   Private Industry
8. Verle Garwood
   Director of Public Works
9. Bob Hopkins
   Plant Superintendent
10. Rick Gamel
    Iowa DPI

Kirkwood Community College

11. Eldon DeCamp
12. Harold Kort
13. Larry Willis
14. Phil Koundakjian
15. Cynthia Root
16. Doug Feil
17. Charlie Bardonner

ATTACHMENT 1.2

Minutes of Water and Wastewater Technology Program

Kirkwood Community College

March 2, 1978

Advisory Committee members, excluding Kirkwood staff, were asked to nominate candidates for the position of Chairman of the Advisory Committee. Four persons were nominated and staff was directed to prepare a ballot for mailing to all members of the Committee. The ballot and return envelope is attached. Committee members are asked to mark their ballot and return to Kirkwood by mail.

A list of the present Advisory Committee is attached. The names of five additional persons were suggested for addition to the Committee. Mr. Bardonner will ask these persons if they will serve on the Committee. They include:

1. James Resnick, Davenport
2. Paul Noland, Cedar Rapids
3. Neil Fischer, Iowa City
4. Wig Shakespeare, Fairfax
5. Reed Craft, Waterloo

Mr. Bardonner updated the Committee on the status of certification recognition, program activity, and proposed program modifications.

Certification Status

1. Mr. Bardonner was directed at the Fall, 1977, meeting to request that the Board of Operator Certification name one of its members to serve on the Kirkwood Advisory Committee. The request was submitted; the Board of Certification declined the the request at their February, 1978, meeting. The board then enacted a policy statement "that the board would not designate any of its members to serve on any committee as a representative of the board." The board then explained that this did not imply that any of its members could not serve on committees as individuals, only not as representatives of the board serving on another committee.

2. The current "Rules and Certification" and "Guidelines for Substitution of Education" result in Kirkwood Water and Wastewater Technology program completers being eligible for Grade II examination nine months after completing the program. Mr. Bardonner again stated his total disagreement with this, but that he would not be challenging it with the same level of activity he had been for the past seventeen months. He also informed the Committee that that existing Rules and Guidelines also result in some instances in which the Kirkwood program completer becoming eligible for Grade III examination as early as one year and three months after completing the Kirkwood program.

Program Activity

1. Mr. Bardonner shared a copy of an article which appeared in the recent Hach Chemical Company Newsletter, which is distributed internationally. A copy is attached. Several inquiries have been received by Kirkwood about the activity, including a telephone call from Manitoba, Canada, requesting an admission form as he is considering possibly enrolling next fall.

2. Mr. David Hall, Kirkwood, briefed the committee on the status of the statewide operator task analysis report and program modifications which have been indicated by these results. A final report will be completed no later than March 31, 1978.

Proposed Program Modifications

1. Mr. Hall then presented the proposed day time program schedule. The modifications proposed are primarily a renaming of courses to better define the program. The modifications enable students to begin the day program in either the Fall or Winter Quarter. Part time students would also be accepted. Schedules for fall and winter entry are attached.

2. Mr. Hall then presented the proposed evening section schedule, also attached. This schedule enables a student to complete the total program in two years, all evening coursework averaging 12 hours per week, Monday through Thursday. Enrollments would be accepted in either Fall or Spring Quarters, and enrollments in less than the full 12 hours would also be accepted. Both day time and eveing programs would include additional related instruction as an option to the internship quarter.

The Advisory Committee endorsed all of the proposed modifications. There was discussion of the importance of relating the proposed programs to the attainment of certification. The Advisory Committee suggested that an effort be made to reach the communities with information about the program. The Iowa League of Municipalities Magazine was suggested as an appropriate avenue to publicize the program.

The meeting adjourned at 2:30 p.m.

Attendees:

Harry Boren
Ron Stellick
George Milligan
Paul Noland
Larry Willis
Charles Bardonner

Harold Kort
Eldon DeCamp
Doug Feil
Cynthia Root
David Hall
Phil Koundakjian
Paul O'Leary